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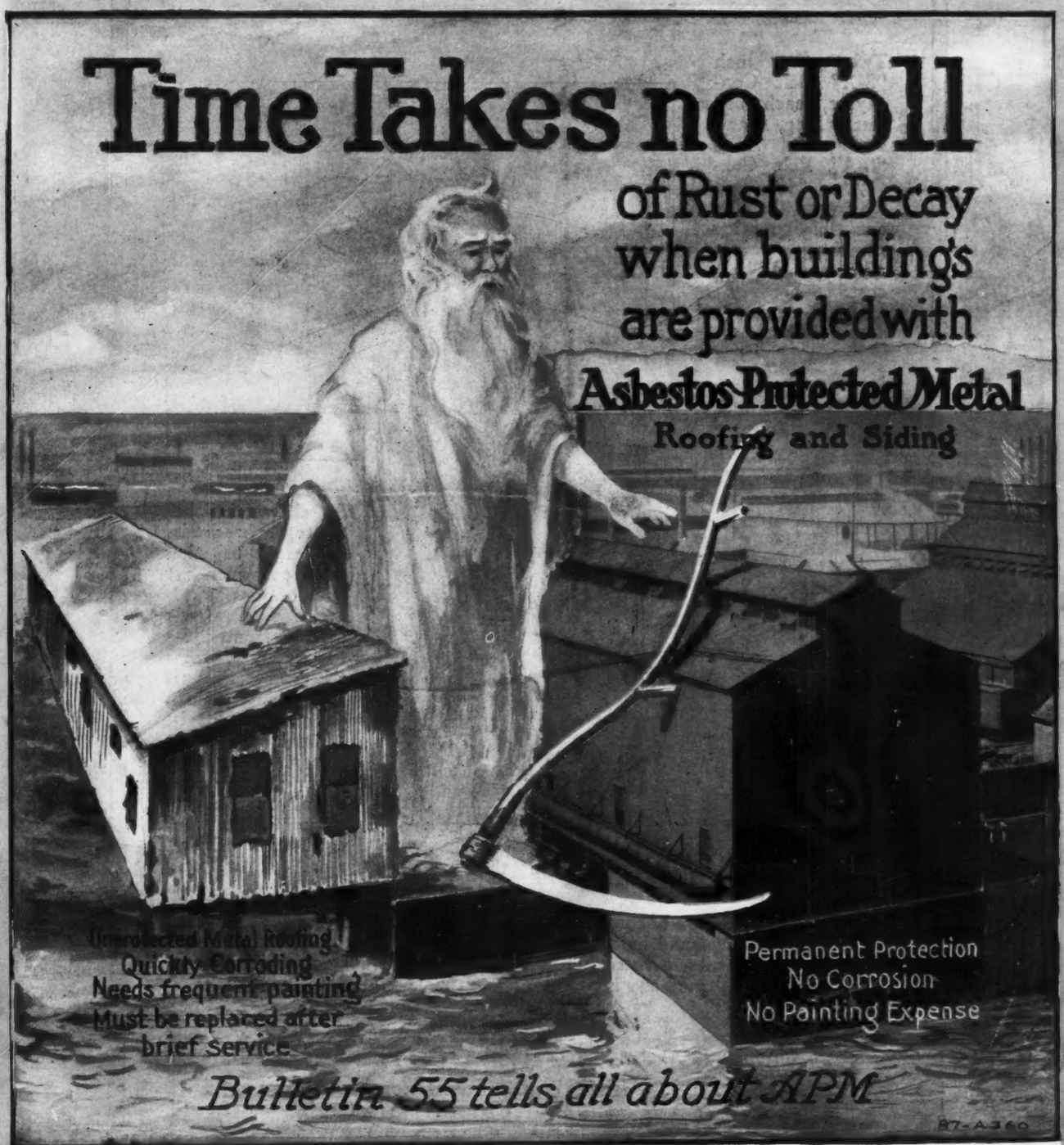

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Engineering and Mining Journal

January 11, 1919

Volume 107 *Number* 2

Theodore Roosevelt

In the death of Theodore Roosevelt, not only did the United States of America lose its greatest citizen, its greatest man, but also the whole world lost a leader and a friend. Roosevelt was never greater than during the last four years, when he held no office; but certainly it has been truly said "if our soldiers were given the great privilege of turning the tide in France, if our ideals are now impressing themselves upon all the earth, it is because Theodore Roosevelt, by pen and voice, awakened us and compelled us to look and listen."

While America mourns its loss and at the moment does not know who will replace him, Roosevelt himself, if he had been able to communicate a parting message to his countrymen, would have repeated his words when he was shot and was in danger of death in 1912:

> It matters little about me, but it matters all about the cause we fight for. If one soldier who happens to carry the flag is stricken, another will take it from his hands and carry it on. One after another the standard bearers may be laid low, but the standard itself can never fall. You know that personally I did not want ever to be a candidate for office again, and you know that only the call that came to the men of the sixties made me answer it, in our day as they did more nobly in their day. And now, as then, it is not important whether one leader lives or dies. It is important only that the cause shall live and win. Tell the people not to worry about me, for if I go down another will take my place. For always the army is true. Always the cause is there, and if it is the cause for which the people care, it is the people's cause.

But, however inspiring be those noble words, this country cannot but mourn the untimely death of one of the greatest Americans of all time.

Introduction

We are precluded by the exigencies in connection with the issuance of the Annual Review Number, which months ago was preëmpted for special purposes, from paying the tribute that we should ordinarily to two distinguished Americans who have died since we last went to press. We refer, of course, to Theodore Roosevelt and Rossiter W. Raymond. Theodore Roosevelt died suddenly on Jan. 6. Dr. Raymond died, also suddenly, on Dec. 31. In our next issue we shall publish a biographical sketch of Dr. Raymond.

The successful completion of the Great War brought a realization of the vital importance of the metal industry as one of the fundamental requirements needed to combat oppression and to insure peace.

We regret the unavoidable limitation of the number of pages in the Annual Review Number and the resultant circumstance that the publication of a few additional papers and reviews must necessarily be deferred for future issues. At the same time, a glance at the index page will show that few subjects of importance or interest have not been presented in the succeeding pages.

The production of the more important metals is summarized in the table on this page. The details appear on subsequent pages. It will be found that in some cases our contributors give figures that do not agree with our own. The explanation of such differences will generally be that the articles of outside contributors were necessarily written and put into type before our own statistics were available. The necessity of handling the great mass of material in this number in a few days leaves no time for leisurely comparison and revision to effect a careful coördination of all the data.

PRODUCTION OF METALS IN THE UNITED STATES

Metal	Unit	1916	1917	1918
Copper (*a*)	Pounds	1,942,776,309	1,922,555,907	1,869,949,686
Gold (*b*)	Dollars	92,590,300	83,750,700	68,493,500
Iron	Long tons (*f*)	39,434,797	(*f*) 38,621,216	38,820,000
Lead (*c*)	Short tons	592,241	581,716	550,729
Nickel (*e*)	Pounds	72,611,492	75,510,793	62,994,376
Silver (*b*)	Troy ounces	74,414,802	71,740,362	67,879,206
Zinc (*d*)	Short tons	680,018	682,411	525,122
Quicksilver (*g*)	Flasks	29,932	35,954	35,000
Tin	Short tons		6,065	10,300

(*a*) Production from ore originating in the United States. (*b*) The statistics for 1916 and 1917 are the final and those for 1918 are the preliminary statistics reported jointly by the directors of the Mint and the U. S. Geological Survey. (*c*) Production of refined lead from ore and scrap originating in the United States; antimonial lead is included. (*d*) Total production of smelters, except those treating dross and junk, exclusively; includes spelter derived from imported ore. (*e*) Imports; for 1918, first 10 months only. This nickel is refined in the United States for the production of metal, oxide and salts. (*f*) American Iron and Steel Institute. (*g*) U. S. Geological Survey.

PRODUCTION OF MINERAL AND CHEMICAL SUBSTANCES

Substance	Unit	1916	1917	1918
Coal, anth. (*a*)	Short tons	87,578,493	99,611,811	99,473,000
Coal, bitu. (*a*)	Short tons	502,519,682	551,790,563	585,883,000
Iron ore (*a*)	Gross tons	75,167,672	75,288,851	72,630,237
Magnesite (*a*)	Short tons	154,974	316,838	225,000
Petroleum (*a*)	Barrels	300,767,158	335,315,601	345,500,000
Potash (*a*)	Short tons	9,720	32,573	60,000

(*a*) U. S. Geological Survey.

In general there were no great increases in the production of any of the major metals in 1918, either in the United States or in the world. Speaking of the United States, pig iron and lead were about stationary. Copper decreased a little and zinc a good deal. The noteworthy features in the world's statistics so far as available are the large decrease in gold production, a small decrease in copper production and a small increase in lead production. Gold mining suffered from causes peculiar to itself. The world's producing capacity for copper and lead was manifestly taxed to the utmost.

To all of the contributors who assisted in the preparation of this number, and also to the many who collaborated in the collection of statistical information, we tender our thanks. We also gladly thank the producers of copper, lead, spelter, and other metals, minerals, and ores who have communicated to us the amount of their output in 1918 and have thereby enabled a close approximation to the actual production of that year to be made by Jan. 8, 1919, the time at which this issue went to press.

Metal Markets

NEW YORK—Jan. 8, 1919

The metal markets this week have been rather chaotic, especially copper. On the other hand, lead seems to be beginning to find itself. A free market seems to be developing in American tin. Irregularities everywhere are only natural under the conditions of the markets, which are just emerging from state control.

Copper—On Jan. 2 electrolytic copper was offered for January-March delivery at 20½c., but that failed to develop business, and there were reports of several million pounds having been bought by a large manufacturer at 20c. On Jan. 3 business to the amount of several hundred thousand pounds for January delivery was certainly done at 20c., and sales were made at that figure on each day thereafter. At the same time 21c. was reported realized in some quarters, and even 23c., but as to the one sale reported at the last figure there were special conditions, wherefore it may be disregarded as an index of the market. The large producers, who are nominally asking 23c., made no sales. Such business as was done during the week was by small producers, of whom at least three made sales. The aggregate of their business was not more than 5,000,000 lb., which, of course, is insignificant in comparison with the amount of copper that has to be sold even to dispose of current production. We are unable at present to determine how the business of this week should be quotationally represented. At a later date, with further information, we may be able to supply figures for each day subsequent to Jan. 1 for the purpose of computing an average for the month. As yet there is no real market for copper in the ordinary sense. It can be bought, but it cannot be sold except in sporadic and limited ways. Even if producers should reduce their prices drastically, they would probably be unable at the moment to sell materially more copper than now. The market is still in a trance, out of which it has got to come and then find himself.

Cables were received from London today to the effect that the British government is offering its electrolytic copper to consumers at £105, which would be 22.26c. Freights are variously reckoned at 3 to 3½c., and insurance and other charges at ¼ to ½c., and the New York equivalent of the London price is computed to be 18¾ to 19 cents.

Copper Sheets—The base price of copper sheets is 33c. per lb. Copper wire is quoted at 22½c. per lb. f.o.b. mill, carload lots.

Tin—This market was stagnant, but there were repeated offers to sell American tin 99% grade, and the indications are that an independent market has developed upon this basis. We resume tin quotations upon this basis.

Lead—After declining to 5½c., speculative interest seemed to be aroused, and sellers, being averse to seeing the metal pass into the hands of such interests at any such figure, withdrew their offers and demanded higher prices. This naturally stimulated the interest of consumers, who always buy on a rising market rather than on a falling, and some business was done with them, which, although small in the aggregate, was, nevertheless, considerably larger than the total of the previous week. Toward the close of this week the market exhibited a fair degree of stability around 5¾c., New York.

The reason for the advance in lead in London on Nov. 26 from £29 net to £40 net was solely the desire of the British government to establish the market values at or about cost. All the lead imported into England, making due allowance for freights, war risk and other insurances, exchange as well as financial arrangements, cost the government much above the figure of £29 at which the metal was released for war purposes. There are now no war purposes, and the necessity for the government maintaining the lower level ceased to exist. The London market will sooner or later return to the control of normal trading conditions.

Zinc—This market continued to slide off on relatively small business. High-grade spelter, guaranteed 99.9%, was sold at 8¼c., and this had an effect upon the market for common spelter. Indeed, the situation in high-grade spelter has been for six weeks back dominating the market for common spelter to a greater degree than has commonly been appreciated.

Zinc Sheets—Price now $13 per 100 lb.

SILVER AND STERLING EXCHANGE

Jan.	Sterling Exchange	Silver New York, Cents	Silver London, Pence	Jan.	Sterling Exchange	Silver New York, Cents	Silver London, Pence
2	4.7585	101⅛	48 7/16	6	4.7580	101⅛	48 7/16
3	4.7585	101⅛	48 7/16	7	4.7580	101⅛	48 7/16
4	4.7580	101⅛	48 7/16	8	4.7580	101⅛	48 7/16

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London quotations are in pence per troy ounce of sterling silver, 925 fine.

DAILY PRICES OF METALS IN NEW YORK

Jan.	Copper Electrolytic	Tin Spot.†	Lead N. Y.	Lead St. L.	Zinc St. L.
			5¼	5¼	7.35
2	*	68¼	@5¼	@5.60	@7.45
			5¼	5¼	7.30
3	*	68¼	@5¼	@5.60	@7.40
			5¼	5.60	7.30
4	*	68¼	@5¼	@5.70	@7.40
				5.60	7.30
6	*	68¼	5¼	@5.70	@7.40
				5.60	7.30
7	*	68¼	5¼	@5.70	@7.35
				5.60	7.25
8	*	68¼	5¼	@5.70	@7.30

The above quotations are our appraisal of the average of the major markets based generally on sales as made and reported by producers and agencies, and represent to the best of our judgment the prevailing values of the metals for the deliveries constituting the major markets, reduced to basis of New York, cash, except where St. Louis is the normal basing point.

Quotations for spelter are for ordinary Prime Western brands. We quote New York price at 35c. per 100 lb. above St. Louis.

* Undetermined.

† For American tin of 99% grade.

LONDON

Jan.	Copper Standard Spot	Copper Standard 3 M.	Copper Electrolytic	Tin Spot	Tin 3 M.	Lead Spot	Lead 3 M.	Zinc Spot
2	112	90	(a)	235	231	40	35	56
3	(a)	89	122	236	232	40	35	57
4-5								
6	92	87	122	242	236¼	40	35	56
7	95	87	105	256	248	40	35	56
8	92	87	105	257	247½	40	35	56

(a) Not received.

The above table gives the closing quotations on London Metal Exchange. All prices are in pounds sterling per ton of 2240 lb.

Other Metals

Aluminum—Unchanged at 33c. per lb.

Antimony—Very dull, with a little business done at 7¾c., which we quote.

Bismuth—Metal of the highest purity for pharmaceutical use is quoted at $3.50 per lb. for wholesale lots—500 lb. and over.

Cadmium—Quoted at $1.50@1.75 per pound.

Nickel—Market quotation: Ingot, 40c.; shot, 43c.; electrolytic, 45c. per pound.

Quicksilver—Weak at $110. No quotation received from San Francisco.

Silver and Platinum

Silver—The demand for silver is still for India chiefly, although London's requirements are about 1,000,000 oz. weekly. Some moderate orders are occasionally in the market for France. Silver for Scandinavian ports has not yet been released, although there are orders in hand for that section for about 500,000 oz. Shipments for last week to London were 1,088,000 ounces.

Mexican dollars at New York: Jan. 2, 77½; Jan. 3, 77½; Jan. 4, 77½; Jan. 6, 77½; Jan. 7, 77½; Jan. 8, 77½.

Platinum—Refined ingot is quoted at $105. The U. S. Assay Office is reported to be no longer offering.

Palladium—Unchanged at $125.

Zinc and Lead Ore Markets

Joplin, Mo., Jan. 4—Blende, per ton, high, $57.60; basis 60% zinc, premium, $50; Class B, $45; Prime Western, $45@42.50; sludge, $42.50@40; flotation, $40@37.50; Calamine, basis 40% zinc, $35@30. Average selling prices: Blende, $43.88; calamine, $34.40; all zinc ore, $43.76.

Lead ore, high, $83.25; basis 80% lead, $80@65; average selling price, all grades of lead, $67.90 per ton.

Shipments the week: Blende, 8837; calamine, 120; lead, 1212 tons. Value, all ores the week, $474,220.

Sales were made last week on a schedule basis for premium ore of $55 for premium blende, but advices this week from the U. S. Attorney General notified buyers and sellers that no price arrangements would be longer permitted by the Government after Jan. 1, and the buyers of premium ore purchased this week on the open market on a basis of $50.

On account of the mines having been forced to close, and a strong demand coming for concentrates, a number of buyers withheld their ore on $42.50 offerings and were later awarded a $45 basis.

Other Ores

Manganese and Chrome Ore—Unchanged.

Tungsten Ore—High-grade wolframite and scheelite offered at $16@17 per unit.

Pyrites—Spanish pyrites is quoted subject to the raising of the embargo, at 16½c. on the basis of 10s. ocean freight. Restrictions still continue. Unchanged.

Iron Trade Review

PITTSBURGH—Jan. 7

The whole iron and steel market is extremely dull. Furthermore, there are no indications that the market will pick up in the near future. No one expects any activity within three months, and already there are those who do not see how a revival can occur in less than six months.

There is a large volume of contract business on the books of steel mills, and it is in specifications against such contracts, rather than in strictly new buying, that activity would be expected to be developed first. The mills are now running chiefly on business that was entered during the war or in the first few weeks afterward, when buyers enjoyed the novel experience of being able to place specifications and orders with knowledge that they would be filled promptly. A few mills are operating at 80 to 90% of capacity, but many are operating at 70% and some at less, so that the average for the whole industry is under 70%, with prospects of still lighter operations within 30 days.

Shipments of finished-steel products under contracts are being made chiefly at the reduced prices that were named last month. In some quarters there are rumors that even before the armistice was signed some mills went out quietly and sold a round tonnage of material at greater cuts below the Government prices than were made openly last month.

There is considerable talk about adoption of the new contract form, which provides for reciprocal damages in case of failure to carry out the contract. Most of the mills state that they will "adopt" the new contract, but whether they would enforce it is another matter. At the present time buyers are quite indisposed to sign the old form of contract, much less the tighter form now proposed.

Pig Iron—The majority of furnaces are strong in their determination to enforce their contracts, chiefly at Government prices, despite the $3 reduction that has now become general. The contracts are legally enforceable, but a question of policy intervenes. Requests for cancellation have been numerous, probably covering more than half the contract business on books. On light sales a market has been established at $3 under the old Government limits, this being in line with the reduction named in the general schedule of reductions that was formulated for presentation to the War Industries Board Dec. 11, but which the board refused to receive. The steel producers adopted the steel reductions at once as already reported, the blast furnaces holding off for a time. We now quote: Bessemer, $32.20; basic, $30; No. 2 foundry, $31; malleable, $31.50; forge, $30, f.o.b. basing point, freight from Valleys to Pittsburgh being $1.40.

Gold and Silver

THE production of gold was checked further in 1918 in all parts of the world, owing to the greatly increased costs for labor and material. In 1918 the plight of the gold miners became very serious, and among them there was clamor for Governmental relief, which demand had a certain sound economic ground, in that the governments had practically impounded gold and prevented a free flow of it, either into commerce or into industry. The British government appointed a commission, and the American Government a committee, to consider this subject; but the advent of peace, with the prospect of declining prices for commodities and labor, will probably remove the necessity of considering the case of the gold miners.

GOLD PRODUCTION OF THE WORLD (a)

	1916	1917	1918
United States	$92,590,300	$83,750,700	$68,500,000
Canada	19,235,000	15,200,000	14,000,000
Mexico	7,690,700	9,000,000	10,000,000
Russia	22,500,000	18,000,000	10,000,000
India	11,206,500	10,756,800	10,100,000
South Africa	192,182,900	186,503,400	176,000,000
South America	15,188,400	14,634,600	15,000,000
Australasia	40,475,800	35,945,500	26,700,000
All other countries	53,106,900	49,799,200	47,000,000
Totals	$454,176,500	$423,590,200	$377,300,000

(a) Figures for 1916 and 1917 are from the Director of the Mint; 1918 figures are our own estimates.

GOLD PRODUCTION OF THE WORLD FOR 20 YEARS

1899	$311,505,947	1909	$459,927,482
1900	258,829,703	1910	454,213,649
1901	260,877,429	1911	459,377,300
1902	298,812,493	1912	474,333,268
1903	329,475,401	1913	462,669,558
1904	349,088,293	1914	451,582,129
1905	378,411,754	1915	473,124,590
1906	405,551,022	1916	(a) 454,176,500
1907	411,294,458	1917	(a) 423,590,200
1908	443,434,527	1918 (estimated)	377,300,000

(a) As reported by the Director of the Mint.

At this early date the gold production of the world in 1918 can be only approximated. We have the statistics of the Director of the Mint and United States Geological Survey for the United States, and official figures for the British colonies for 10 or 11 months. We can do no more than guess at the production in other countries. However, their aggregate is a minor part of the total. In making the estimate for Russia, we have had the assistance of experts in gold mining in that country.

GOLD AND SILVER PRODUCTION OF THE UNITED STATES (a)

(Gold, Value; Silver, Fine Ounces)

	Gold		Silver	
	1917	1918	1917	1918
Alabama	$2,200	$700	.....	2
Alaska	14,671,400	9,108,500	1,207,164	796,863
Arizona	5,180,600	5,760,200	6,962,257	6,771,490
California	20,929,400	17,207,000	2,107,107	1,555,417
Colorado	15,974,500	12,853,500	7,291,495	6,982,313
Georgia	6,500	3,500	.....	41
Idaho	754,800	636,000	11,402,542	10,188,056
Illinois	.....	.....	7,116	8,939
Maryland	.....	.....	538	164
Michigan	.....	.....	684,225	491,939
Missouri	300	200	63,344	40,948
Montana	3,673,200	3,170,600	14,555,034	15,341,793
Nevada	6,932,500	6,662,000	11,217,654	10,113,405
New Hampshire	.....	.....	.....	.....
New Mexico	1,085,400	638,200	1,535,807	763,758
North Carolina	10,800	800	590	9
Oregon	1,687,300	1,260,000	172,152	150,207
South Carolina	1,700	.....	.....	.....
South Dakota	7,372,900	6,786,700	190,382	165,865
Tennessee	5,500	5,400	106,975	131,931
Texas	100	100	587,945	612,436
Utah	3,522,100	3,142,500	13,360,905	13,439,811
Vermont	100	800	403	5,117
Virginia	1,300	400	4,500	2,967
Washington	488,200	342,300	266,112	302,446
Wyoming	3,700	400	3,400	719
Continental U. S.	$82,304,500	$67,579,800	71,727,647	67,866,609
Philippines	1,446,100	913,700	12,715	12,597
Porto Rico	100	.....	.....	.....
Total	$83,750,700	$68,493,500	71,740,362	67,879,206

(a) As reported by the directors of the United States Mint and the Geological Survey.

Without any doubt the world's production of gold in 1918 declined in the neighborhood of $50,000,000; while the decline in 1917, as compared with 1916, was about $25,000,000.

The gold and silver production of the United States for 1918, given in the table, are preliminary estimates. Revised figures will be published later in the year.

Silver in 1918

BY EDWARD BRUSH*

IT IS MORE than usually difficult to estimate the production of silver during 1918, for the reason that the statistical reports as to the commerce of the United States include considerable quantities of coin imported and very large quantities of silver bars exported. These bars were derived from the melting of the Sherman Law dollars held in the Treasury of the United States, and represented by silver certificates in circulation. These statistics prove nothing, therefore, as to the production of silver from the mines of this country or of such countries as largely import their silver product into the United States.

The normal effect of an increased value would be to increase production. The average New York quotation for bar silver during the year 1917 was 89½c. per oz., and for the year 1918 approximately 97⅞c. Here again the normal deductions cannot be depended upon, as the well-known increase in cost of production undoubtedly more than offset the effect of the increase in value.

We must not fail, also, to consider that the value of lead and copper has nearly as great an effect on production as that of silver itself. Taking all of these forces into account, and with the knowledge which has come to the writer regarding the production of many representative mines, it is safe to believe that the silver production of the United States for the year 1918 will not be more than 4,000,000 oz. below that of the year 1917, which was reported by the Director of the Mint as amounting to 71,740,400 ounces.

There are many reasons for the belief, however, that the production of the world has shown an increase. The value of the imports of silver into the United States for the first ten months of 1917 is reported as $38,099,586, whereas for the same period of the year 1918 it is reported as $61,549,381, fully 70% of which was received from Mexico. It would seem safe to estimate the total imports for the entire year from Mexico at $52,500,000, or approximately 50,000,000 oz. The Director of the Mint reports the silver production of Mexico for 1916 as 22,838,400 oz. and for 1917 as

*Vice-president American Smelting and Refining Co., 120 Broadway, New York.

31,214,000 oz. Both of these amounts are much below the yearly production previous to the Madero administration, the cause being the unsettled condition of the country. It is well known that many mines in Mexico, which had not produced or had produced only to a minor extent during 1917, were able to produce during 1918.

But these facts will hardly account for an increased production from 31,000,000 oz. to 50,000,000 oz. Mexico, however, has been denuded of her silver circulation, except that of the minor coins, and many pesos have been imported and are included in the imported values quoted above. If we assume that, of the increased importations, approximately one-half were pesos, it would seem safe to estimate the production of Mexico for 1918 as 40,000,000 ounces.

The importations from Canada, Central America, and South America also show notable increases. A world production for the year 1918 of 180,000,000 oz. would be a fair estimate, against 164,000,000 oz. for 1917.

On Apr. 23, 1918, there was approved an act of Congress entitled "An act to conserve the gold supply of the United States; to permit the settlement in silver of trade balances adverse to the United States; and for the above purpose to stabilize the price and encourage the production of silver." Since the passage of this act, there has been no free market for silver in this country or in London. From Apr. 25 to Aug. 19, New York quotation only varied from 99½c. to 99¾c., and from August there was no change in the quotation of $1.01⅛ per oz. to the end of the year. Previous to the passage of this act, the New York quotation was fixed at the parity of the London quotation, but since Aug. 19 last, the New York quotation has controlled, and the London quotation has been derived by adding the transportation and insurance expense of shipment to London to the quotation made at New York.

MONTHLY AVERAGE PRICE OF SILVER (*a*)

Month	New York			London		
	1916	1917	1918	1916	1917	1918
January	56.775	75.630	88.702	26.960	36.682	44.356
February	56.755	77.585	85.716	26.975	37.742	42.792
March	57.935	73.861	88.082	27.597	36.410	43.260
April	64.415	73.875	95.346	30.662	36.963	47.215
May	74.269	74.745	99.505	35.477	37.940	48.980
June	65.024	76.971	99.500	31.060	39.065	48.875
July	62.940	79.010	99.625	30.000	40.110	48.813
August	66.083	85.407	100.292	31.498	43.418	49.077
September	68.515	100.740	101.125	32.584	50.920	49.500
October	67.855	87.332	101.125	32.361	44.324	49.500
November	71.604	85.891	101.125	34.192	43.584	48.969
December	75.765	85.960	101.125	36.410	43.052	48.492
Year	65.661	81.417	96.772	31.315	40.851	47.516

New York quotations, cents per ounce troy, fine silver; London, pence per ounce sterling silver, 0.925 fine.

(*a*) *Engineering and Mining Journal* prices.

The desire of the Director of the Mint and of the Reserve Bank that such an act should be passed was known to the writer when compiling the article on "Silver in 1917," printed in the *Journal* of Jan. 12, 1918, through various consultations with representatives of the Reserve Bank, the Director of the Mint, as well as senators and members of the House of Representatives. Reference was made to these plans as follows: "The only source of supply of spot silver in any quantity is the silver dollars held in the United States Treasury as security against the circulation of silver certificates. The subject is being seriously considered on the part of various governmental departments, on account of the war needs in connection with India products, whether proper legislation can be obtained whereby the temporary use of this silver in dollar coins can be authorized, the silver to be returned through Government purchases at a maximum price which it is expected will make possible an increased production of silver." On account of these plans being confidential at that time, no more specific reference was expedient. Although the negotiations began in October, 1917, the act was not presented to Congress until April, 1918, but was immediately passed and without opposition. Whether this fact means the permanent burial of the historic gold-versus-silver feud is beyond our ken, but it was certainly notable that the act was of equal interest to both parties to the currency disputes of the Bryan campaigns. The negotiations preceding the drafting of the act were between representatives of the Reserve Bank and of the British government. The latter were the buyers of the silver needed by India, and at first were unwilling to pay more than 85c. per oz. At this price, they doubtless could have purchased the major portion of the annual production of the country. But this production was not sufficient to meet the needs which were in sight for the coming year. The coined dollars were the only supply of spot silver which could fill the crying demand, but they could not be used without legislation, the passage of which at first seemed very doubtful. Many senators representing the silver-producing states insisted that the old ratio value of $1.29 per oz. should be reëstablished, but this price undoubtedly could not have been paid by Great Britain. Even if the price could have prevailed for a while, due to war necessities, the act would have undoubtedly soon fallen by its own weight, as was the case with the Sherman Silver-Purchase Act.

The agreement to fix the price at $1 per oz. was reached very largely through the conservative judgment, the political sagacity, and the indomitable perseverance of Governor Emmet D. Boyle of Nevada. I have taken much space to relate the history of this act of Apr. 23, 1918, as it undoubtedly is the most notable legislation with reference to silver since the repeal of the free-coinage acts of France and India. So far as can be seen at this writing, this act should hold the price of silver for many years at $1 per oz. The act authorizes the sale of 350,000,000 one-dollar coins, and to the end of the year 1918 there had been sold approximately 160,000,000 coins, or somewhat less than one-half the number provided for. The sale of dollars was limited by the act to an equal retirement of silver certificates, and also, inferentially, to the issuance of Federal Reserve bank notes. These two requirements have no doubt largely, and perhaps permanently, reduced the sale of dollars. At first, it was found difficult to withdraw the silver certificates from circulation, and later the delays in engraving the plates for Reserve bank notes and the printing of them were both unexpected and unfortunate.

With the cessation of the war, there has come to India a serious failure of fall rains, and large sections of country are facing famine. The India government has prohibited the exportation of wheat and other grains, and London has ceased the sale of drafts on India. It becomes doubtful, therefore, as to how much longer the British government will continue to purchase dollar coins, in addition to the entire surplus current production, together with imported coins. In the opinion of the best judges, the purchases are likely to continue for three months longer, and the total shipments of dollars

will not exceed 200,000,000. As the Director of the Mint is compelled to purchase at $1 per oz. all the silver which is offered to him, and as only the surplus not needed for coinage or commercial purposes can be offered, it does not seem probable that the director will be likely to complete the purchase of 200,000,000 oz. for many years to come.

The next serious question to be decided, which may have even a greater effect on silver prices, and consequently on silver production, than all that has happened during the year 1918, is whether the free distribution of gold throughout the world will again be permitted. The gold production of the world is very largely in the hands of the United States and Great Britain and her colonies. Both nations are creditor nations, and, therefore, able to restrict the exportation of gold. The exigency of war has brought home to every one the fact that at least there has been no surplus of gold in the world. With the greatly increased international business which is expected to be done in the coming years by these two

YEARLY DEMAND FOR SILVER

	Ounces
For India	150,000,000
For Africa	25,000,000
For the arts	75,000,000
For subsidiary coinage	60,000,000
For China, etc	40,000,000
Total	350,000,000
Production	180,000,000
Shortage	170,000,000

leading countries, is there not going to be a continued shortage of the yellow metal, especially in connection with its decreased production? The greatest absorber of the world's production of gold has been India. In the article on Silver in the *Journal* of Jan. 12, 1918, it was mentioned that India had imported, previous to the war, $150,000,000 yearly in gold, leaving only a similar amount of new production for the coinage and bank reserves of the whole world. Will Great Britain permit this condition to prevail again? It hardly seems probable. But if she does not, then silver must be substituted if it can be found or produced.

The use of silver for subsidiary coinage is also likely to largely increase. Gold has completely left many countries, and it is not probable that it can be restored to circulation for many years. At the same time, the paper currency has been greatly increased, and silver will be required as a basis. This plan will be much more conservative on account of the fact that the price of silver is fixed by the act of Apr. 23 last than would have been the case previous to the war. With the possibility of gold being withheld from India, a conservative estimate as to the yearly demands for silver is shown in the accompanying table.

There seems to be abundant room for an increased production, which can be brought about only by an increased price.

Necrology

Among the noted men identified with the mining and metallurgical industries who died in 1918 were:

William Hague	Jan. 1	William B. Phillips	June 7
A. A. Blow	Jan. 2	James Douglas	June 25
Thomas L. Livermore	Jan. 9	John Duer Irving	July 26
Edward McKim Hagar	Jan. 19	Adolph Faber du Faur	Aug. 18
F. W. Matthiessen	Feb. 11	Charles Richard Van Hise	Nov. 19
Thomas F. Noon	Mar. 2	Rossiter W. Raymond	Dec. 31
Grove Carl Gilbert	May 1	DuBois, Howard W.	Nov. 1
Edgar A. Collins	June 3		

Bituminous Coal and Coke

The estimated production of 585,883,000 net tons of bituminous coal and lignite in the United States in 1918, according to the U. S. Geological Survey, sets a new high record, with an increase of 34,000,000 tons or 6.2%, over 1917. Production in 1918 was more than sufficient to meet the needs of the country. By Nov. 11 the average stocks over the United States were sufficient for seven weeks, and the cessation of war activities and warm weather in November and December made it seem advisable to many consumers to begin using storage coal earlier than is usual.

Although the bituminous coal mines lost to the military service and to other lines of industry in 1917 and 1918 more than 125,000 men, the loss has been largely made up, in numbers if not in effectiveness, by addition to the forces, and it is not believed that for the country as a whole the number of men employed in 1918 will show any noticeable decrease below the 603,000 in 1917. It is estimated that the bituminous mines worked on an average 255 days in 1918, compared with 243 in 1917 and 230 in 1916.

The production of coke in 1918 is estimated at 56,670,000 net tons, compared with 55,606,828 tons in 1917, an increase of 1,603,000 tons, or 3%. Byproduct-coke production is estimated at 26,264,000 tons, an increase of 3,825,000 tons, or 17%, compared with 1917. Beehive coke is estimated to have decreased 2,762,000 tons, or 8%, from 33,167,548 tons in 1917 to 30,406,000 tons in 1918. The largest gain in output of byproduct coke was in Ohio, 1,737,000 tons, followed by Pennsylvania, with 595,500 tons. Indiana produced 3,870,000 tons of byproduct coke, an increase of 329,000 tons. Colorado was added in 1918 to the list of states producing byproduct coke with the starting up of the plant of the Colorado Fuel and Iron Company at Pueblo. In 1917 byproduct coke represented 40% of the total output; in 1918, 46%. In October the production of byproduct coke exceeded that of beehive, and from that date forward it is expected that the proportion of coke from the new type of ovens will continue to increase. The year 1918 should definitely and finally record the passing of supremacy from the beehive coke oven to the byproduct oven.

Petroleum in 1918

Preliminary estimates by John D. Northrop, of the U. S. Geological Survey, Department of the Interior, indicate that the quantity of crude petroleum marketed from oil wells and field storage tanks in the United States in 1918 reached the record-breaking total of 345,500,000 bbl., an apparent gain of 3% over the former record of 335,315,601 bbl., established in 1917. The output is apportioned among the major fields as follows:

OUTPUT OF PETROLEUM IN UNITED STATES IN 1917 AND 1918

Field	1917	1918
Appalachian	24,932,205	25,300,000
Lima-Indiana	3,670,293	3,100,000
Illinois	15,776,860	13,300,000
Oklahoma-Kansas	155,043,596	139,600,000
Central and North Texas	10,900,646	15,600,000
North Louisiana	8,561,963	13,000,000
Gulf	26,087,587	21,700,000
Rocky Mountain	9,199,310	12,600,000
California	93,877,549	101,300,000
Alaska and Michigan	10,300	.....
Totals	335,315,601	345,500,000

The Quicksilver Market

At the beginning of 1918 the price for quicksilver was $115, San Francisco, and $130, New York, the latter market being at a rather large premium owing to the shortage of spot supplies. The deficiency was soon relieved, however, and the New York price declined to $125. During the remainder of 1918 the quotations were pretty steadily $115, San Francisco, and $125, New York, the fluctuations above and below those figures being but trifling.

AVERAGE MONTHLY PRICE OF QUICKSILVER

(Per Flask of 75 Lb.)

Month	1917 New York	1917 San Francisco	1918 New York	1918 San Francisco
January	$81.04	$80.20	$126.7708	$115.5769
February	120.90	116.25	119.8863	116.9565
March	113.30	112.50	121.6346	115.8269
April	115.64	115.00	121.8654	115.4615
May	105.98	105.00	118.9730	113.3076
June	84.34	86.20	122.6600	113.4800
July	107.80	102.18	126.6346	116.6923
August	115.00	111.10	125.5555	118.3333
September	112.21	110.90	127.8125	119.0000
October	100.94	100.62	127.1759	119.3333
November	102.50	100.75	124.9130	118.9130
December	115.90	111.65	117.7000	115.6000
Year	$106.30	$104.36	123.4651	116.5401

In April the Government made arrangements with the producers for the supply of its requirements at $105, basis San Francisco, the producers delivering supplies pro rata. Otherwise the market was left free. In December the price declined to $115, New York, the San Francisco price remaining at $115.

Average Monthly Prices of Palladium*

(In Dollars per Ounce)

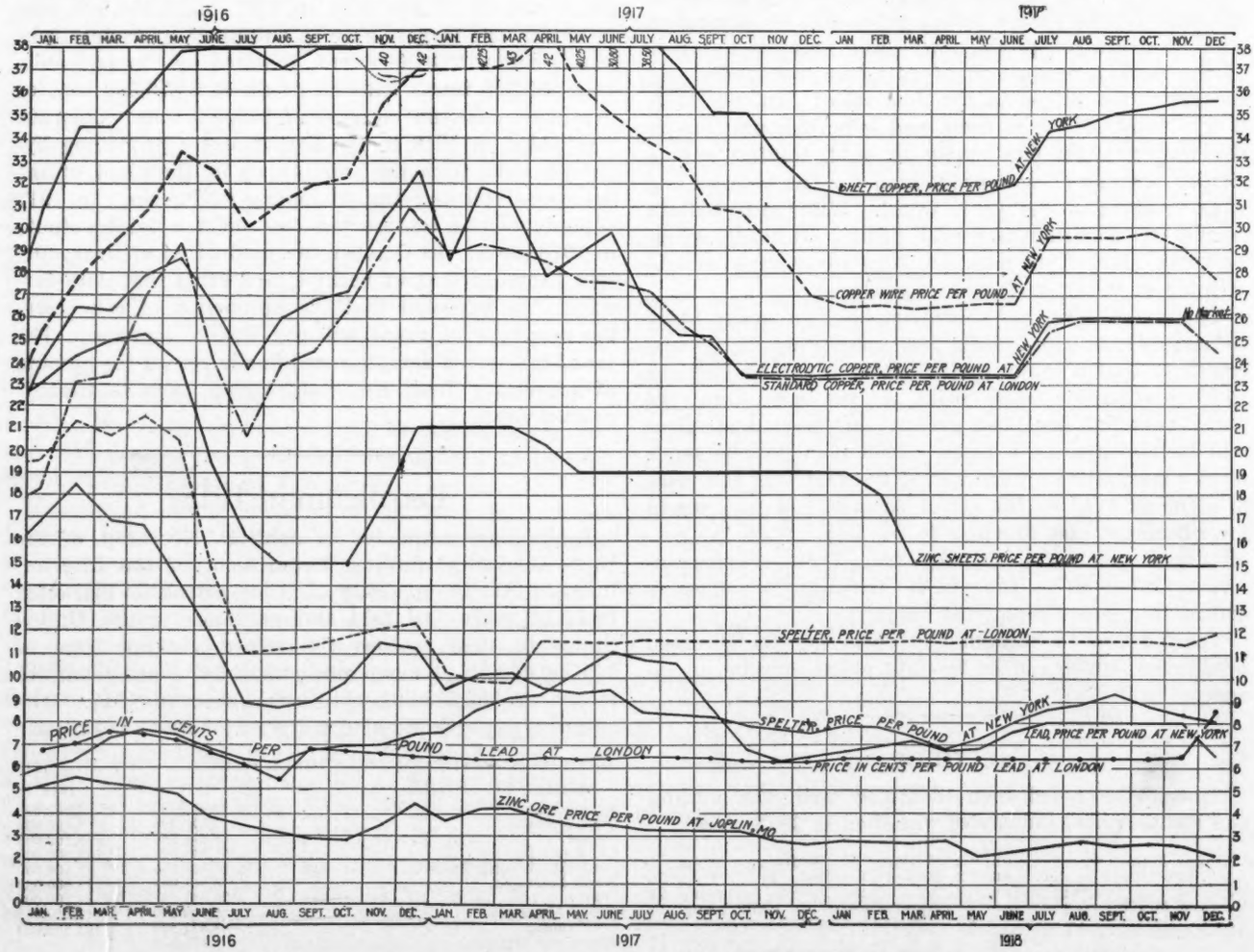
	1917		1917
January	73.00	July	113.60
February	88.32	August	120.00
March	88.05	September	123.44
April	93.70	October	121.92
May	104.00	November	126.87
June	108.29	December	130.60
Year			107.65

	1918		1918
January	135.00	July	135
February	137.50	August	135
March	144.0386	September	135
April	150.00	October	135
May	142.3076(a)	November	135
June	135.00	December	128.6
Year			137.2871

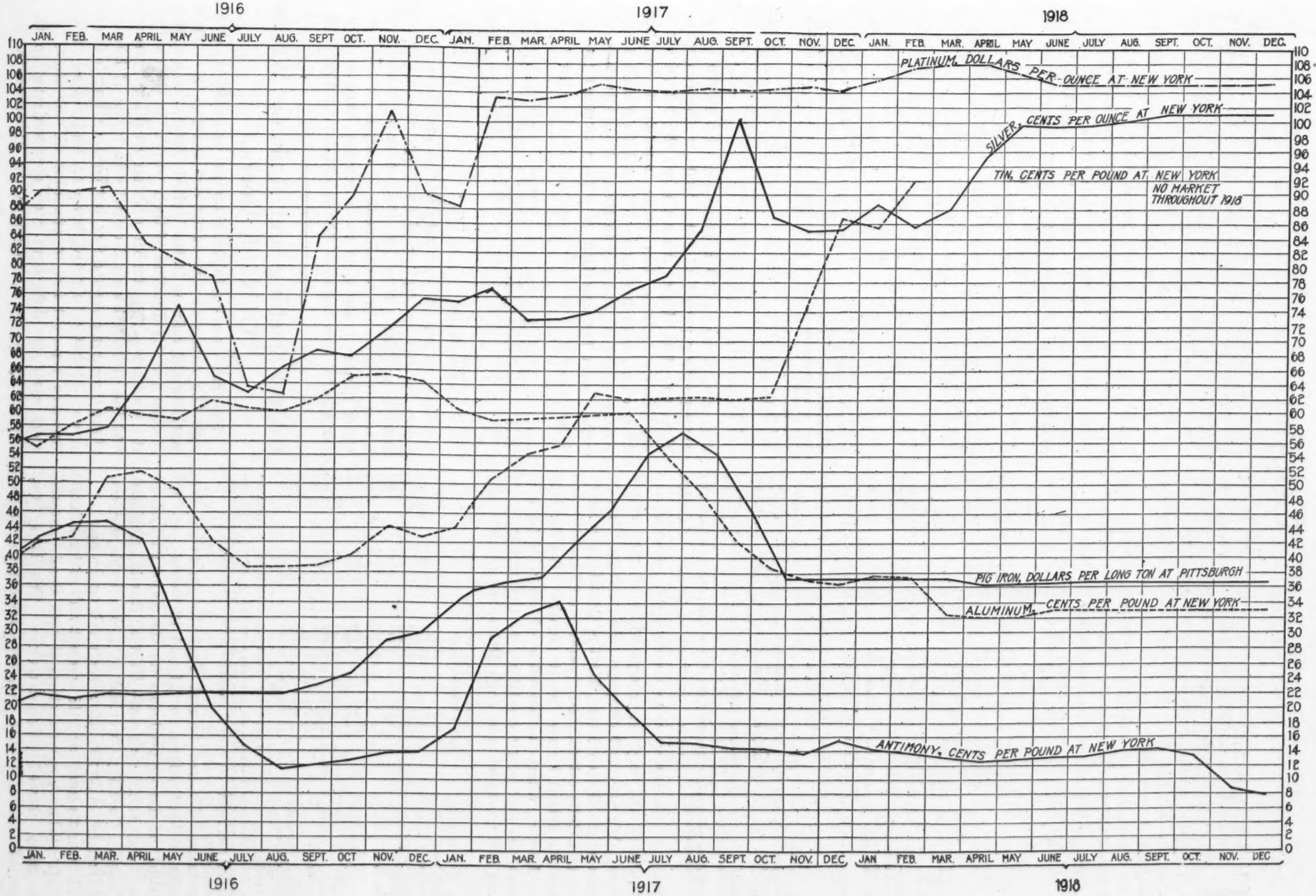
* *Engineering and Mining Journal* quotations. (a) Fixed May 14 at 135.

Feldspar During 1918—The production of feldspar in 1918 was the largest ever recorded, according to the U. S. Geological Survey, and that of 1917 was 141,924 short tons, or 7% greater, than was produced in 1916. Of the 1917 production, 84% was utilized in the manufacture of pottery, chinaware, porcelain, tile, enameled brick and similar products; 6% was consumed in the manufacture of roofing material, artificial stone, artificial marble, and the surfacing of concrete; and 5% was used in the manufacture of cement for the purpose of increasing the percentage of the potash in the flue dust, which is treated in some cases by the Cottrell and Steer electrostatic processes.

The New York price for crude feldspar in 1918, as reported to the U. S. Geological Survey, was about $5 per long ton, as compared with $3.40 in 1917. The price of ground feldspar averaged, in 1918, $12 per short ton, as compared with $10.15 in 1917, and $9.30 in 1916.


1916
1917
1918
JAN. FEB. MAR. APRIL MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
SHEET COPPER, PRICE PER POUND AT NEW YORK
COPPER WIRE PRICE PER POUND AT NEW YORK
ELECTROLYTIC COPPER, PRICE PER POUND AT NEW YORK
STANDARD COPPER, PRICE PER POUND AT LONDON
ZINC SHEETS, PRICE PER POUND AT NEW YORK
SPELTER, PRICE PER POUND AT LONDON
SPELTER, PRICE PER POUND AT NEW YORK
LEAD, PRICE PER POUND AT NEW YORK
PRICE IN CENTS PER POUND LEAD AT LONDON
ZINC ORE PRICE PER POUND AT JOPLIN, MO.
PRICE IN CENTS PER POUND LEAD AT LONDON

MONTHLY PRICE AVERAGES OF BASE METALS AND THEIR MANUFACTURES, 1916, 1917, 1918


1916
1917
1918
JAN. FEB. MAR. APRIL MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
PLATINUM, DOLLARS PER OUNCE AT NEW YORK
SILVER, CENTS PER OUNCE AT NEW YORK
TIN, CENTS PER POUND AT NEW YORK
NO MARKET THROUGHOUT 1918
PIG IRON, DOLLARS PER LONG TON AT PITTSBURGH
ALUMINUM, CENTS PER POUND AT NEW YORK
ANTIMONY, CENTS PER POUND AT NEW YORK

MONTHLY AVERAGES OF METAL PRICES, 1916, 1917, 1918

Copper

THE principal statistics for 1918 are given in the accompanying tables, which tell their own stories. They afford opportunities for numerous studies, but, completed, as they have been, by telegraph and cable within the last two days, we do not venture hastily to make any deductions.

We are glad to be able to make within a week after the end of the year an estimate of the world's production of copper which experience has shown to be only 1 or 2% out of the way, as compared with the revised figures. We have had complete returns from the producers of the United States, Mexico, Canada, and Cuba. Peru and Chile cabled their figures for 12 months and Japan its official figures for 10 months. We received from London, where are the offices of the principal producers, the best possible estimate of the production of Spain and Portugal, and from Melbourne the best for Australia. We had returns from the principal producers in South Africa for 11 and 12 months, and for most of the smaller producers for the major part of the year. For some countries—Bolivia, Russia, etc., and, of course, Germany—we had to make simple guesses, but their totals do not amount to much anyhow.

SMELTERS' PRODUCTION OF COPPER IN THE UNITED STATES
(In Pounds)

State	1915	1916	1917	1918
Alaska	72,621,844	115,933,315	92,094,023	59,326,000
Arizona	444,089,147	692,630,286	704,156,391	765,744,496
California	37,935,893	51,358,334	46,824,320	57,576,860
Colorado	8,126,000	9,802,183	11,894,900	4,596,200
Idaho	5,602,000	6,741,001	6,401,988	5,068,500
Michigan	241,123,404	270,058,601	274,936,224	216,759,810
Montana	268,027,557	351,995,058	277,362,886	324,970,446
Nevada	66,394,906	100,143,431	115,436,671	86,361,023
New Mexico	75,515,138	83,013,805	110,020,997	91,462,362
Utah	180,951,174	225,396,808	244,443,071	230,019,737
Washington	(a)	(a)	2,152,560	2,189,030
East and South	18,858,677	20,018,261	18,704,304	16,630,377
Other states and undistributed	4,452,420	15,685,226	18,127,568	9,264,845
Totals	1,423,698,160	1,942,776,309	1,922,555,903	1,869,949,686

SMELTERS' TOTAL PRODUCTION
(In Pounds)

Source	1915	1916	1917	1918
North American ore	1,612,450,828	2,187,328,864	2,161,627,729	2,179,825,960
Foreign ore	44,749,105	73,391,517	74,410,422	37,334,001
Scrap	29,827,203	37,380,759	41,821,811	37,903,934
Totals	1,687,027,136	2,298,101,140	2,277,859,962	2,255,063,895
To foreign refiners	39,734,120	38,423,577	33,261,435	34,088,084
To American refiners	1,647,293,016	2,259,677,563	2,244,598,527	2,220,975,811
Crude copper imported	140,415,341	152,770,536	274,813,001	268,746,428
Total crude copper	1,787,708,357	2,412,448,099	2,519,411,528	2,489,722,239

WORLD'S PRODUCTION OF COPPER (a)
(In Metric Tons)

Country	1915	1916	1917	1918
United States	646,212	881,237	872,065	848,203
Mexico	30,969	55,128	47,503	75,529
Canada	47,202	47,985	50,626	52,693
Cuba	8,836	7,816	10,313	12,337
Australasia	32,512	35,000	38,100	33,838
Peru	(d) 32,410	(d) 41,625	(d) 45,620	(d) 44,800
Chile	47,142	64,636	(d) 83,100	(d) 85,850
Bolivia	(e) 3,000	(e) 4,000	(e) 4,000	(e) 4,000
Japan	(b) 76,039	(b) 101,467	(c) 111,256	(c) 95,800
Russia	25,881	20,887	(e) 16,000	(e) 5,000
Germany	(e) 35,000	(e) 45,000	(e) 45,000	(e) 40,000
Africa	27,327	34,572	45,138	31,110
Spain and Portugal	(e) 46,200	(e) 42,000	(e) 42,000	(e) 41,000
Other Countries	(e) 25,000	(e) 25,000	(e) 25,000	(e) 25,000
Totals	1,083,730	1,406,353	1,435,721	1,395,160

(a) The statistics in this table are our own compilations, except where specially noted to the contrary. (b) As officially reported. (c) Privately communicated to us from Japan. (d) From L. Vogelstein & Co. (e) Estimated.

The world's total for 1918 was not very different from that for 1917. A few countries showed small increases, but many showed large decreases. The latter was especially the case with the more remote countries—Australia, South Africa, and Japan. Owing to transportation conditions, Great Britain and France found it preferable to get their supplies from nearer countries. Also, it was said last summer that Japan did not care to sell at the price officially fixed.

During the first eight months of 1918 Japan exported 21,800 long tons of copper, compared with 53,750 tons in the same period of 1917. Although the production of Japan declined considerably, the export figures rather indicate a stock there. Similarly, the exportation of only 7900 tons of blister copper from Spain during the first nine months of 1918, compared with 13,579 in the corresponding period of 1917, leads to the conjecture of a small stock there. Australia has about 25,000 tons, and South Africa has some unshipped supplies. America probably had about 1000 million pounds at the refineries and on the way to them. This situation, together with the cessation of copper consumption for munitioning and the natural delay in making arrangements for the resumption of ordinary industrial work, created a difficult situation for producers, who were bound to institute curtailment of output in order to check further increase in their financial burden. This curtailment was begun at the mines during December.

IMPORTS OF COPPER DURING FIRST TEN MONTHS
(In Pounds)

	1916	1917	1918
Ore, matte, etc., contents	150,962,096	142,483,807	131,620,644
Unrefined, blister copper, etc.	229,578,498	294,253,505	324,172,156
Refined bars, plates, etc	8,411,163	6,045,747	32,267,821
Old and miscellaneous	8,643,233	17,997,760	1,181,916
Totals	397,594,990	460,078,819	489,242,537

EXPORTS OF COPPER IN FIRST TEN MONTHS
(In Pounds)

	1916	1917	1918
Ore, matte, etc., contents	4,676,049	4,873,733	3,198,339
Unrefined, blister, etc	11,326,996	10,198,256	14,015,713
Refined ingots, bars, etc	610,968,882	871,449,230	600,746,005
Plates and sheets	12,338,816	33,372,534	14,542,622
Wire, except insulated	20,049,866	21,024,056	13,388,066
Old and scrap	785,157	949,556	235,003
Composition metal, copper chief value		(a) 1,196,947	133,616
Copper pipes and tubes		(a) 6,165,449	3,366,445
Totals	660,145,766	949,229,761	649,625,809

(a) Figures cover period beginning July 1.

REFINED COPPER PRODUCTION IN THE UNITED STATES, 1918
(In pounds, according to figures of Copper Producers' Association)

January	152,557,010	May	212,955,831	September	203,509,819
February	152,397,014	June	206,892,064	October	173,133,522
March	190,350,369	July	223,994,742	November	210,838,108
April	205,443,430	August	201,462,134	December (est.)	215,520,000
Total production in 1918					2,349,054,043
Total production in 1917					2,350,240,606

Copper-Smelting and Refining Works Of North America

The accompanying tables, corrected up to Dec. 1, 1918, give the names of the companies engaged in copper smelting and refining in the United States, Canada, and Mexico and the situation of their works. In the case of the smelteries, the number of their smelting furnaces and the estimated annual capacity in terms of tons of charge, meaning ore and flux, but not including fuel, are given. It should be noted, however, that not all of the furnaces reported are in operation all the time. In most cases the data have been communicated to the *Journal* by the operating companies. However, the fig-

ures should be taken as only approximately correct. Some companies may have figured their annual capacity on the basis of the year of 365 days, and others on the basis of 350 days, or something else. Anyway, annual capacity is a rather variable figure. In modern practice a rather large quantity of ore is reduced directly to copper by charging it into the converter along with matte, this being shown separately in some cases by the last column of the table.

The smelting companies of Lake Superior, reported in the table, treat copper concentrate, which is chiefly metallic copper, produced by the ore-dressing works of that region.

The plant of the United Verde Extension Mining Company, in Arizona, was completed and placed in operation during 1918. No works were permanently closed down, although several were idle at the end of the year.

COPPER-SMELTING WORKS OF NORTH AMERICA

Company	Situation of Works	No. of Blast Furnaces	Annual Capacity	No. of Reverberatory Furnaces	Annual Capacity	No. of Converters	Annual Capacity in Ore (a)
American Smelting and Refining Co	Aguascalientes, Mex	6	480,000	..	.....	4	(b)
American Smelting and Refining Co	Perth Amboy, N. J	1	90,000	..	.....	3	(b)
American Smelting and Refining Co	Omaha, Neb	..	.....	..	.....	2	(b)
American Smelting and Refining Co	El Paso, Tex	4	400,000	4	580,000	4	(b)
American Smelting and Refining Co	Matehuala, S.L.P., Mex	4	435,000	..	.....	..	.....
American Smelting and Refining Co	Hayden, Ariz	..	.....	4	580,000	4	(b)
American Smelting and Refining Co	Sasco, Ariz	2	300,000	..	.....	2	.....
American Smelters Securities Co	Garfield, Utah	4	800,000	7	1,022,000	9	(b)
American Smelters Securities Co	Tacoma, Wash	3	560,000	1	144,000	4	(b)
American Smelters Securities Co	Velardeña, Dgo., Mex	3	250,000	..	.....	..	.....
Anaconda Copper Mining Co	Anaconda, Mont	3	1,750,000	9	1,980,000	7	105,000
Anaconda Copper Mining Co	Great Falls, Mont	4	675,000	2	210,000	2	49,000
Arizona Copper Co	Clifton, Ariz	..	.....	3	360,000	3	.....
Compagnie du Boleo	Santa Rosalia, Mex	7	700,000	..	.....	..	.....
Calumet & Arizona Mining Co	Douglas, Ariz	2	633,500	5	997,500	6	350,000
Canada Copper Corpn (f)	Greenwood, B. C	3	912,500	..	.....	2	52,000
Cananea Consolidated Copper Co	Cananea, Son., Mex	8	868,000	2	153,000	..	.....
Consolidated Arizona Smelting Co	Humboldt, Ariz	1	90,000	1	160,000	6	35,000
Consolidated Mining and Smelting Co	Trail, B. C	4	207,000	..	.....	2	5,000
Copper Queen Branch, Phelps Dodge Corpn. (e)	Douglas, Ariz	..	.....	..	.....	..	.....
Detroit Copper Mining Co. (c)	Morenci, Ariz	..	.....	..	.....	..	.....
Ducktown Sulphur, Copper and Iron Co	Isabella, Tenn	2	150,000	..	.....	..	.....
East Butte Copper Mining Co	Butte, Mont	2	225,000	..	.....	4	5,000
Granby Consol. Mining, Smelting and Power Co	Grand Forks, B. C	8	1,400,000	..	.....	3	7,000
Granby Consol. Mining, Smelting and Power Co	Anyox, B. C	4	1,330,000	..	.....	5	110,000
International Nickel Co. of Canada (e)	Copper Cliff, Ont	8	1,166,000	1	174,000	6	64,500
International Smelting Co	Tooele, Utah	..	.....	5	500,000	5	50,000
International Smelting Co	Miami, Ariz	..	.....	4	700,000	5	50,000
Ladysmith Smelting Corpn. (f)	Ladysmith, B. C	2	236,250	..	.....	..	.....
Mammoth Plant, U. S. Smelting, Refining and Mining Co	Kennett, Calif	5	700,000	..	.....	2	28,500
Mason Valley Mines Co	Thompson, Nev	2	419,192	..	.....	2	16,930
Mazapil Copper Co	Concepcion del Oro, Zac., Mex	2	144,000	..	.....	..	.....
Missouri Cobalt Co	Fredericktown, Mo	1	35,000	..	.....	..	.....
Mond Nickel Co	Coniston, Ont	4	700,000	..	.....	4	60,000
Mountain Copper Co	Mococo, near Martinez, Calif.	..	.....	1	60,000	2	5,500
Nevada Consolidated Copper Co	McGill, Nev	..	.....	5	900,000	4	20,000
Nichols Copper Co	Laurel Hill, N. Y	1	100,000	..	.....	4	.....
Norfolk Smelting Co	West Norfolk, Va	1	87,500	..	.....	2	5,250
Phelps Dodge Corpn., Copper Queen Branch	Douglas, Ariz	10	1,596,000	3	490,000	8	106,400
Phelps Dodge Corpn., Morenci Branch	Morenci, Ariz	1	193,200	..	.....	3	9,800
Old Dominion Co	Globe, Ariz	3	450,000	..	.....	2	8,500
Orford Works, International Nickel Co	Constable Hook, N. J	2	94,500	..	.....	3	.....
Penn Mining Co	Campo Seco, Calif	..	.....	2	72,000	1	42,000
Santa Fe Gold and Copper Co	San Pedro, N. M	1	45,000	..	.....	..	.....
Shannon Copper Co	Clifton, Ariz	2	400,000	..	.....	2	5,612
Swansea Consol. Gold and Copper Mining Co. (f)	Bouse, Ariz	1	190,000	..	.....	2	.....
Tennessee Copper Co	Copperhill, Tenn	5	1,000,000	..	.....	2	15,000
Teziutlan Copper Mining and Smelting Co	Teziutlan, Puebla, Mex	2	350,000	..	.....	3	.....
Cia. Metalurgica de Torreon	Torreon, Coah., Mex	2	175,000	..	.....	2	.....
U. S. Metals Refining Co	Chrome, N. J	2	200,000	..	.....	3	(b)
U. S. Smelting Co. (f)	Midvale, Utah	..	.....	..	.....	..	.....
United Verde Copper Co	Clarkdale, Ariz	4	685,000	3	400,000	6	50,000
United Verde Extension Mining Co	Clarkdale, Ariz	1	175,000	1	175,000	3	350,000
Wanakah Mining Co. (d)	Ouray, Colo	2	105,000	..	.....	..	.....
Western Smelting & Power Co	Cooke, Mont	1	110,000	..	.....	..	.....

(a) Raw ore smelted as flux. (b) Included in furnace tonnages. (c) See Phelps Dodge Corporation. (d) Plant sold to Ouray Smelting and Refining Co. (e) Formerly Canadian Copper Co. (f) Not in operation.

LAKE SUPERIOR SMELTING WORKS

Company	Situation of Works	No. of Blast Furnaces	Annual Capacity	No. of Reverberatory Furnaces	Annual Capacity
Calumet & Hecla Mining Co	Hubbell, Mich	1	75,000	21	150,000
Lake Superior Smelting Co	Dollar Bay, Mich	1	50,000	7	75,000
Michigan Smelting Co	Houghton, Mich	1	45,000	5	85,000
Quincy Smelting Works	Hancock, Mich	1	20,000	4	35,000

ELECTROLYTIC COPPER REFINERIES OF THE UNITED STATES AND CANADA

Works	Situation	1915 Capacity, Pounds (a)	1916 Capacity, Pounds (a)	1917 Capacity, Pounds (a)	1918 Capacity Pounds (a)
Nichols Copper Co	Laurel Hill, N. Y.	400,000,000	450,000,000	500,000,000	500,000,000
Raritan Copper Works	Perth Amboy, N. J.	400,000,000	460,000,000	460,000,000	460,000,000
Baltimore Copper Smg. and Rolling Co	Canton, Md.	354,000,000	600,000,000	720,000,000	720,000,000
American Smelting and Refining Co	Maurer, N. J.	240,000,000	240,000,000	288,000,000	288,000,000
United States Metals Refining Co	Chrome, N. J.	200,000,000	250,000,000	250,000,000	250,000,000
Balbach Smelting and Refining Co	Newark, N. J.	48,000,000	48,000,000	48,000,000	48,000,000
Anaconda Cop. Min. Co. (old plant)	Great Falls, Mont.	65,000,000	65,000,000	65,000,000	65,000,000
Anaconda Cop. Min. Co. (new plant)	Great Falls, Mont.	(b)	180,000,000	180,000,000	180,000,000
Tacoma Smelting Co	Tacoma, Wash.	120,000,000	130,000,000	204,000,000	204,000,000
Calumet & Hecla Mining Co	Hubbell, Mich.	65,000,000	65,000,000	65,000,000	65,000,000
Consolidated Mining and Smelting Co	Trail, B. C.	(b)	8,400,000	14,000,000	14,000,000
Totals		1,892,000,000	2,495,400,000	2,794,000,000	2,794,000,000

(a) Official figures furnished by the respective companies. (b) New works put into operation in 1916.

The Copper Market in 1918

At the beginning of 1918 the United States and foreign governments were requiring a good deal of copper, as were also domestic manufacturers, especially the wire drawers, who were working more or less directly for Government purposes. The chief feature of interest at this time was the growing appreciation of how transportation difficulties and coal shortage might diminish the production of the refineries. Even as early as this, important plants were losing time owing to lack of coal, and it was anticipated that they would suffer further from the non-delivery of raw material; in fact, both of these fears were realized, besides which there were many other difficulties. Among these was the tardiness of the Government in making payment to the producers, which was due to the embarrassments of red tape. At about this time no less than

MONTHLY AVERAGE PRICE OF COPPER

	New York				London Standard			
Month	1915	1916	1917	1918	1915	1916	1917	1918
January.....	13.641	24.008	28.673	23.500	60.756	88.083	131.921	110.000
February....	14.394	26.440	31.750	23.500	63.494	102.667	137.895	110.000
March.....	14.787	26.310	31.481	23.500	66.152	107.714	136.750	110.000
April.....	16.811	27.895	27.935	23.500	75.096	124.319	133.842	110.000
May.....	18.506	28.625	28.788	23.500	77.600	135.457	130.000	110.000
June.....	19.477	26.601	29.962	23.500	82.574	112.432	130.000	110.000
July.....	18.796	23.865	26.620	25.904	76.011	95.119	128.409	119.913
August.....	16.941	26.120	25.380	26.000	68.673	110.283	122.391	122.000
September...	17.502	26.855	25.073	26.000	68.915	113.905	117.500	122.000
October.....	17.686	27.193	23.500	26.000	72.601	122.750	110.000	122.000
November...	18.627	30.625	23.500	26.000	77.744	134.659	110.000	122.000
December...	20.133	31.890	23.500	(a)	80.773	145.316	110.000	118.447
Year.....	17.275	27.202	27.180	24.628	72.532	116.059	124.892	115.530

New York, cents per pound. London, pounds sterling per long ton of standard copper. (a) No market.

$16,000,000 was owed to the copper producers. The War Department was the chief offender. Relations with the Navy Department were relatively satisfactory.

On Jan. 10 the copper producers held a meeting, at which they discussed the matter of a new agreement with the Government as to price. It was well known among them that many of the smaller producers were having not altogether an easy time, the increase in the cost of production since September being variously estimated at from 1c. to 3c. per pound.

The meeting with the War Industries Board occurred on Jan. 22, at which time it was announced that the 23½c. price would be continued until June 1. Although the producers were disappointed by this decision, they continued to push production as energetically as they could. The requisitions for copper continued unabated, except that during February there was a lull in shipments to Europe, many ships being tied up here on account of lack of coal, and shipping room being required for the carriage of supplies that were more urgently needed. The refiners in the vicinity of New York had great difficulty in getting both coal and crude copper to their works, and several of them were in imminent danger of being obliged to suspend production. The situation was even more dangerous than in the previous year, for not only was the interference with traffic worse, but also manufacturers in Connecticut, who were now relying upon governmental supply, did not carry in their yards the amount of reserve stock that they did formerly. However, about the middle of February, the settlement of the longshoremen's strike and freer deliveries of blister copper for the railways relieved the situation at the copper refineries, and soon they began to be troubled rather by crude copper coming in more rapidly than they could handle it, which condition prevailed during the remainder of the year. About the middle of March, the refineries were operating at about four-fifths the average rate of production in 1917. By the end of March, the immediate difficulties of the refineries had been pretty well overcome, but at no time during 1918 were they able to operate at full capacity. Many times the prospect seemed fair for increased rates of production, but invariably something happened that upset the calculations.

During the second quarter of 1918 there was no event of special importance, but the insatiable demands of labor, the increasing inefficiency of labor, and the unwillingness of a portion of the force to work more than one-third of the time restrained production and increased costs so that refiners who were operating on the basis of tolls fixed under pre-war conditions found themselves in a serious predicament. Some of the producers in the high-cost districts, such as Lake Superior and Clifton-Morenci, also found conditions very troublesome. There was considered to be such good grounds for an advance in the price for copper that it was confidently expected that something would be granted by the War Industries Board in May. At the meeting on May 22, however, which was largely attended by the copper producers, some of whom had come as far as from the Pacific Coast, it was calmly announced at the end of a long day of discussion that the board had made up its mind on the previous day to keep the price at 23½c. until Aug. 15. This led to some acrimonious remarks by the producers, who refused to assent to an "agreement" to that effect, and some rather hard feeling resulted. In the meanwhile, the refiners were hard pressed to furnish the full quantity of copper that was required and were steadily far behind in filling their orders. Melting and molding was one of their particular troubles; to help in this brass-makers were induced to use cathodes to some extent instead of ingots.

However, it soon became whispered that the War Industries Board knew that it had made a mistake on May 22, that it would soon be rectified, and in the meanwhile none of the producers was willing to book any order on conditions otherwise than that it would be subject to a new price. In fact there was a suddenly called meeting with the War Industries Board on July 2, when the price was raised to 26c., effective immediately. This did no more, however, than compensate for the advance in freight rates on July 1 and permit the mining companies to grant an allowance to the refiners covering their increased costs. Really the mining companies were worse off than they had been previously, for they had to concede a further advance in wages to their miners. Moreover, there arose complications, both with the Government and private consumers, over orders placed previously to July 2 and not filled. With the Government the producers were forced to compromise a large part of these on the 23½c. basis, so even the 26c. price did not turn out to be all that it looked.

As Aug. 15 approached everybody was expecting a further advance. The high-cost producers were clamoring for special consideration, and there was some absurd talk about making two prices for copper. At the meeting on Aug. 7 the War Industries Board decided simply, however, to maintain the 26c. price until Nov.

1. After this the meetings in Washington lost interest, and that scheduled in October was abandoned and continuance of the price to Jan. 1, 1919, was arranged by correspondence. During the fall the draft, the influenza and the explosion near Perth Amboy added to the troubles of the producers, especially the refiners.

AVERAGE MONTHLY PRICES OF COPPER MANUFACTURES

(In Cents per Pound, f. o. b., Mill)

	1916		1917		1918	
	Copper Wire	Sheet Copper	Copper Wire	Sheet Copper	Copper Wire	Sheet Copper
January	25.70	31.00	37.00	42.00	26.50	31.50
February	28.66	34.50	37.00	42.12	26.56	31.50
March	29.13	34.50	38.11	43.00	26.43	31.50
April	31.10	36.00	38.20	42.20	26.50	31.50
May	33.75	37.88	36.56	40.30	26.62	31.50
June	32.50	38.00	35.00	38.75	26.64	31.90
July	30.25	38.00	34.12	38.22	29.50	34.25
August	31.38	37.00	32.85	36.85	29.50	34.50
September	32.00	38.00	31.00	35.00	29.50	35.00
October	32.35	38.00	31.00	35.00	29.75	35.25
November	35.56	40.37	28.83	33.17	29.00	35.60
December	37.00	42.00	26.84	31.74	27.70	35.65
Year	31.61	37.10	33.87	38.19	27.85	33.30

The armistice on Nov. 11 caught the copper producers with no very large orders on their books. Some large orders that were pending were, of course, suspended. A committee went to Washington on Nov. 15 and made an agreement with the War Industries Board for maintenance of the price at 26c., the producers agreeing to maintain production and wages. This agreement meant nothing more than official sanction of the producers concertedly asking 26c. and getting it if they could. They found that they couldn't. During November they received a few belated and absolutely trifling orders that they filled at 26c., but from Dec. 1 onward they got nothing, and "26c. asked" was merely a fiction in so far as any indication of the market was concerned, for there was no market, and on one side nobody would pay 26c., while on the other side nobody thought anybody would. However, the agreement among the producers themselves prevented any attempt to make a market until after Jan. 1, 1919. Late in December the producers organized an export association under the authority of the Webb law, and announced an asking price of 23c. for the first quarter of 1919, but this was regarded as a feeler rather than as a real hope.

The Butte District

BY B. B. THAYER*

The Butte district, in common with every large producing center, was greatly hampered throughout 1918 by a shortage of labor, due to the selective draft, influenza, and labor disturbances, and though the activities were probably the greatest in the history of the district, the output in pounds of copper was far below that of some normal years. Each and every one of the producing companies, spurred by the war's necessities, aside from the consideration of corporate benefit to be derived, felt it a patriotic duty to make the greatest production possible of the metals so necessary for the successful conduct of the war.

Butte has for many years been one of the banner producing districts of the copper metal, and with the last five years has taken an enviable position among the zinc-producing districts of the world. When war was declared, it was a well-known fact that a great shortage of manganese ores, so essential to the successful production of steel, existed, and, prompted purely by patriotic motives, the Butte companies started in to see if by their endeavors another metallic star might not be added to Montana's service flag. The endeavors were most successful, and the Butte district during 1918 made an output of manganese ores, the beneficial effect of which was materially felt in the steel-producing districts of this country. The development work in the Emma mine, the property of the Butte Copper and Zinc Co., disclosed large bodies of manganese ores of a commercial grade, and during the entire period of the war heavy shipments to the Eastern steel works were maintained from this property. A considerable amount of manganese ores was also shipped from properties in the western part of the district.

In addition to the manganese ores extracted from the Emma mine, a fair tonnage of zinc ores was shipped from this property to the reduction works of the Anaconda Copper Mining Co. at Great Falls.

In the early part of 1918 the Anaconda Copper Mining Co. undertook the erection of a ferromanganese plant at Great Falls. This plant, composed of electric furnaces, was put into successful operation a short time prior to the cessation of hostilities. Every effort was likewise made to produce the greatest amount of arsenic possible, this product being so esential in the activities of the Food Administration and the War Department.

The city of Butte had one of the most prosperous years in its existence, and, judged from a patriotic standpoint, contributed more than its quota in men, money, and metals to the service of the country.

The development work at the various mines in Butte, though somewhat lessened on account of the shortage of man-power, proved quite satisfactory. There were no developments, outside of the manganese production previously mentioned, worthy of note, but, taken as a whole, the Butte district is in a most satisfactory condition, showing no likelihood of a diminution of output, so far as its mines are concerned, and with ample unexplored territory to warrant the belief that upon the return of normal conditions increased development work may bring into production properties which at the present time are unknown.

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Copper Production in Arizona

BY WALTER DOUGLAS*

In marked contrast with conditions prevailing during the previous year, the copper industry of Arizona was practically free from labor disturbances in 1918. This most desirable result was to a large extent due to the able and intelligent control and supervision exercised by Hywell Davies and Joseph S. Myers, Federal Mediators of the Bureau of Labor. With the Government demanding a maximum output of metal, the production reached record proportions, but at the expense, through shortage of skilled labor, of development and exploration in the mines, and proper maintenance of the plants and mechanical equipment.

The production in Arizona for 1918 (the month of December being estimated) will probably attain the high figure of 760,000,000 lb. or approximately 100,000,000 lb. more than in the previous year.

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The 23½-c. price agreed upon between the copper producers and the price-fixing committee on Sept. 21, 1917, remained in force until July, 1918, when an increase of 2½c. per lb. was permitted, to take care of increased costs created by the raise in freight rates and higher tolls demanded by the refiners. A wage increase, amounting to 75c. per day, was also at that time granted to all classes of labor in the industry as a compensation for the increased cost of living. The average copper quotation for the year will, therefore, approximate 2½ c. per lb. less than in 1917; though the cost of production, owing to the above factors, together with marked decrease in labor efficiency, increased greatly.

The most notable contributors to the grand total for the year are the New Cornelia, which completed its first calendar year of regular operation; the Inspiration, the United Verde, the Miami, and the Phelps Dodge Corporation, all of which were retarded in 1917 by strikes which prevented their attaining maximum output. Certain other large producers showed small decreases, due to local conditions, which did not affect the industry as a whole. The new smeltery of the United Verde Extension Mining Co., in the Jerome district, was placed in operation in July, and thereafter that company treated all its own ores and ceased shipments to the custom smelters.

For the first time in many years, it is not possible to report new additions to the number of the larger mines; nor is there immediate prospect of any accession to the list of important copper producers in the state.

For the last four years every property has been pushed to its capacity to get out the maximum tonnage of ore, and has thus been compelled to neglect or postpone its development and exploratory work, so that it is probable that with the pressure removed, the metal production in 1919 will show a very material decrease. Inability to obtain material for construction or repairs has seriously affected the efficiency of the plants, and it will probably take at least six months or a year of heavy expenditures of capital and labor to restore their physical condition to that of the pre-war period, both above and below ground.

With the prospect of a record-breaking demand for the red metal within the next few months, or when satisfactory financing has been arranged, the present situation is ideal to bring operating conditions to a standard which will permit of maximum output within a reasonable time. Producing, as the United States does, nearly 80% of the copper supply of the world, the country will be called upon to furnish the requirements not only of the domestic market but of the large tonnage which will be needed for the rehabilitation of the industrial sections of northern France and Belgium. If, as is estimated, 80% of the copper production in the last three years has entered into the manufacture of essentially war material, the majority of which has been a total loss, there has been only 20% applicable to the peace industries of the world. It is obvious, therefore, that to furnish the necessary supply for normal industrial requirements, replacements, and deferred extensions, the mines of the world will be called upon in the near future for an output that will be inadequate to meet the demand.

With an improved labor supply and a reasonable time in which to prepare, Arizona mines can be confidently counted upon for an increasing output of copper for many years.

Lake Superior Copper Industry in 1918

By James MacNaughton*

The history of the copper industry of the Lake Superior district for the year 1918 might be epitomized in a few words as being the struggle of the producers to maintain a production requisite for the needs of the Government with a constantly decreasing force of men. To accomplish this, it was necessary to stop, as far as possible, all construction work. It was not difficult to do this, because of the impossibility of obtaining materials for construction even where the labor was available. It was also necessary gradually to decrease underground development in the producing properties and to place all labor, as far as practicable, upon the actual production of copper for war material. There was no occasion to place artificial restriction upon the development of new properties, because the high cost of labor and its scarcity made it about impossible for the developing companies to continue at their work.

All told, 18 companies have ceased development work in this district since April, 1917, and the close of 1918 finds search for profitable lodes of importance being made only by the Seneca Copper Corporation and the Mayflower-Old Colony Mining Co. The properties of these companies are situated near large communities, and because of this fact and their treasury balance they have been able to continue this work. It has not been necessary for any of the producing companies to cease production because of the rising costs, but the smaller companies have had a constant struggle to get back a new dollar for an old one, in spite of the high price of copper.

Such development underground as may be recorded was in the direction of power tramming to replace the decreasing man-power. Fortunately some of the companies had ordered electric locomotives in ample season, so that the falling off in production was not in proportion to the decrease in the number of men.

As nearly as may be estimated from the report of the mine inspector, the supply of labor decreased between 25% and 33⅓%, with a falling off of underground labor to a still greater extent than is shown by these figures. There was, however, increased individual production on the part of the men, due not so much to personal efficiency as to mechanical aids, so that the copper production of the district will not show a decrease of 20 per cent.

At the metallurgical plants, no new features of great interest are to be noted. Flotation was being used at the end of 1918 only by the Calumet & Hecla Mining Co. and the White Pine Copper Co., and both these companies had small installations operating. The final capacity of the Calumet & Hecla plant is placed at 4000 tons daily. The Winona Copper Co. is installing a 600-ton plant in its mill, this being the only company with faith in the commercial possibilities of flotation on amygdaloid. The only other metallurgical improve-

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ment in prospect is by the Quincy Mining Co., which is extending its fine-grinding sections.

The "rock" of the district is gradually working lower, almost all the companies showing the same tendency. This is chiefly a factor of depth, although the high price of the metal permits of treating lower-grade "rock." The mines on the Kearsarge Lode are conspicuous in this regard, and Ahmeek, Allouez, Wolverine, and South Kearsage will show a decided decrease in copper content.

With the end of the war the supply of labor became more plentiful, and the "rock" output is again on the increase. Wages were at their highest, and supplies likewise, at the close of 1918, so that the cost per pound of copper produced was at a figure resembling a selling price of previous years. The future of the industry depends upon a continuance of the present high price for the metal or else a decided decrease in the cost of labor and materials, coincident with a lower price for copper.

The Asbestos Industry

Although asbestos has until recently been classed as a "war mineral," the industry is not likely to feel the effect of the cessation of hostilities. This substance is largely used in the construction of ships, and the shipbuilding programs of the various countries insure an active market for asbestos for a long time. During 1918, the demand was strong, and though the supply of domestic asbestos was greater than in 1917, the greater portion of the total amount sold in the United States, as in previous years, came from Canada.

Arizona was the largest and most important producer of asbestos in the United States in 1918, and it is reported that three companies were the chief producers, working in the Ash Creek district, north of Globe. A few prospectors worked their claims, but their properties were not opened up sufficiently to judge further possibilities. In Maryland, residual deposits of amphibole asbestos were worked to some extent, and this product supplied the demand for asbestos in filters, which formerly had been secured by import supply. In California, the Sierra Asbestos Co., near Nevada City, operated a mine and a 100-ton mill, shipping the product to the John D. Hoff Asbestos Co., of San Francisco, general agents for the distribution of this material. The process of fiberizing which that company utilizes is new and efficient, and consists of a jaw crusher, and a 20-stamp mill of 1200-lb. stamps, crushing to ½ mesh. The material is then conveyed to a double shaking screen, and the fiber is taken off the screen by means of suction blowers. The screenings go to a Canadian fiberizer, and, by suction, the fiber is carried to separators and a revolving screen for grading into No. 1, No. 2, and No. 3 mill grade, free from sand. The mine is operated as a quarry, tunnel, and gloryhole system, the ore being taken to the mill by a 1000-ft. aërial tramway. The entire plant is operated by water power.

Several other deposits of crysotile asbestos have been found in California and are being prospected. Amphibole asbestos in California consists of bunches and lenses of ore, but little of it was produced in 1918. The Asbestos and Mineral Corporation of New York deals extensively in asbestos and, incidentally, possesses a splendid collection of asbestos specimens from various countries.

The Canadian asbestos industry was active throughout 1918. Demand was keen, and production was limited only by shortage of labor and shipping facilities. The asbestos-producing districts in Canada are confined to the Province of Quebec, the five centers being Thetford Mines, Black Lake, Robertsonville, East Broughton, and Danville. The first four of these are situated on the Quebec Central Ry., which connects Quebec and Sherbrooke, and the fifth is on the Grand Trunk Ry., 85 miles southwest of the city of Quebec.

During the first nine months of 1918, the Canadian production of asbestos of all grades amounted to approximately 116,000 tons, valued at $6,000,000. For the 12 months of 1917, the figures were 137,000 tons, valued at $7,200,000. The progress of the industry may be gathered from the fact that 10 years ago the yearly production was 65,000 tons, valued at $2,500,000.

As the grading of asbestos has not been standardized, it is difficult to compare prices, except as between the same grades of the same producer. This is aggravated by the fact that the grades are numerous, passing gradually from one to the other, and they vary in value from $5 a ton for low-grade mill stock, very short fiber, to $1500 a ton for selected "Crude No. 1" of fiber of over one inch in length. Average prices for "paper stock" during the last six years have been: 1913, $28 per ton; 1914, $27; 1915, $31.50; 1916, $39; 1917, $53, and 1918, $60 per ton. By far the greater part of the Quebec asbestos is exported to the United States. Next in importance as a consumer of asbestos is England, followed by Japan, France, Italy, and other countries.

The main feature of the Canadian asbestos-mining industry in 1918 was the introduction of the gloryhole method and hoisting by shaft at one of the large mines, that of the Jacobs Asbestos Co., at Thetford, to replace the open-pit method; and the elimination at the Jeffery mine of cable-derricks for hoisting the rock, which is now loaded at the bottom of the open pit by steam shovels on cars which are hauled to the mill in trains. The Quebec Asbestos Co., at East Broughton, has restored its mill after the fire of last spring and is treating about 350 tons daily. The Frasier mine of the Asbestos Corporation completed a mill, and the Montreal property, under option to a Boston syndicate, has begun construction of a mill, which will be completed in the spring. The Regina Asbestos Co. and the Berlin Asbestos Co., at Robertson Station, and the Imperial Chrome and Asbestos Co., at Black Lake, have shown considerable activity. The new milling plant of the Windsor Asbestos Co., at Coleraine Station, was recently burnt to the ground. During 1918, 18 mines were in operation in the Quebec district. The question of cheap handling of the asbestos rock is a vital one, as about 2¾ million tons are hoisted yearly at the present rate of production.

A new supply of asbestos has been found in South Africa in the Asbestos Mountains, in the lower Griquatown beds. The deposits here have been developed as far north as the Bechuanaland Protectorate. The work is carried on by the aid of Kafir labor, and the fiber produced averages 25% of 1 in. or over. For the first seven months of 1918, production of Rhodesian asbestos was 7,834,397 lb., and the 1917 production was 19,932,281 pounds. Rhodesian production has shown a steady increase for the last four years.

Lead

THE production of lead in the United States and in the principal lead-producing foreign countries is given in the accompanying tables. These statistics are based on the production of refined pig lead in the several countries, except that the major part of the lead produced in Mexico is refined in the United States. The second table is not very far from the total production of the world outside of Germany and Austria. The principal omissions are the productions of Great Britain, Greece, and France. French and British

PRODUCTION OF LEAD (REFINERY STATISTICS) (a)
(In Tons of 2000 Lb.)

Domestic:	1914	1915	1916	1917	1918
Desilverized	318,697	305,160	330,189	319,015	282,205
Antimonial	17,177	24,601	22,819	16,265	15,833
S. E. Missouri	177,413	185,849	206,105	205,861	189,063
S. W. Missouri	25,448	20,312	33,128	40,575	63,628
Totals	538,735	535,922	592,241	581,716	550,729
Foreign:					
Desilverized	28,475	43,301	17,832	50,962	107,531
Antimonial	1,119	2,883	3,304	2,991	1,628
Totals	29,594	46,184	21,136	53,953	109,159
Grand totals	568,329	582,106	613,377	635,669	659,888

(a) These figures include the lead derived from scrap and junk by primary smelters.

smelters ordinarily derive considerable ore from Spain and Australia, but during the last two years very little could come from Australia. Burma supplied India and the Orient. Australia supplied the Orient and Great Britain. France got its lead chiefly from Spain, but some of the Spanish lead went to Great Britain. Most

IMPORTS OF LEAD DURING FIRST TEN MONTHS

	1916	1917	1918
Lead ore, long tons	90,735	74,769	78,812
Lead contents, lb.	29,648,109	37,080,482	34,784,290
Lead in bullion, lb.	16,192,013	67,470,096	124,115,162
Lead, pigs, bars and old, lb.	10,522,980	6,875,138	10,479,331

EXPORTS OF LEAD DURING FIRST TEN MONTHS

	1916	1917	1918
Pigs, bars, etc., from domestic ore, lb.	176,593,359	75,996,536	115,176,369
Pigs, bars, etc., from foreign ore, lb.	16,244,637	41,429,855	49,864,777

of the Mexican lead, and in the latter half of 1918 all of it, went to Great Britain, except the small quantity that is consumed in Mexico.

The Spanish exports of lead for the first nine months of 1918 were 115,105 metric tons, compared with 112,274 in the same period of 1917.

At the end of 1918 there were large accumulations of lead in all quarters. In the United States producers and the munitions contractors had about 50,000 tons.

PRODUCTION OF LEAD BY THE PRINCIPAL COUNTRIES
(In Metric Tons)

	1916	1917	1918
United States (a)	537,277	527,729	499,618
Canada	19,550	14,515	19,169
Mexico (b)	22,000	52,937	88,670
Australia	139,000	160,000	175,000
Spain (c)	147,406	180,000	170,000
Burma	11,266	17,137	21,107
Italy	24,362	25,000	25,000
Totals	900,861	977,318	998,564

(a) Production of domestic ore. (b) Production of pig lead in Mexico. Lead smelted from Mexican ore in the United States is not included in this table either under Mexico or the United States. (c) Total production, including Spanish lead smelted abroad.

Trail had 8000, besides which the Canadian government held a good deal. The British Munitions Minister declared 55,000 tons in November, which was probably somewhat diminished by Dec. 31. France and Italy undoubtedly had considerable supplies. Australia was supposed to have a good deal that had not been shipped.

The statistics of production do not show any great changes in the several countries, except in Mexico, where arrangements were made in 1918 that permitted more general mining and smelting. In the last quarter of the year, however, Mexican production was curtailed, and in the last six weeks a drastic curtailment was put into effect by most of the American producers.

The Lead Market in 1918

At the beginning of 1918 lead was quoted at 6½c., New York. The market at that time was exhibiting strong signs of recovery from the depression in the latter part of 1917. The freight congestion had already become an important factor, and premiums were paid locally for lead on the spot or what could be supplied from near-by refineries. By the middle of January the price had advanced from 6¾ to 7c. and the situation had become very tight. Lead was two months in coming from the Mississippi River to the Atlantic seaboard, compared with a normal time of about six weeks, indicating a stock of about 100,000 tons on wheels, against a normal of 25,000 to 30,000. With the advent of February, deliveries by the railways became a little freer. However, the market continued strong on both domestic and foreign buying, February closing with a quotation of 7¼ cents.

There seemed to be strong prospects that lead would go higher, but producers received intimations from the War Industries Board that no advance above 7¼c. would be permitted. Learning of this, consumers made up their minds that they were in no danger of a squeeze, and, their previously purchased supplies of lead being delivered more freely by the railways, they withdrew from the market, and in consequence thereof the price declined to 6½c., which was registered at the end of April. However, their withdrawal from the market was

MONTHLY AVERAGE PRICE OF LEAD

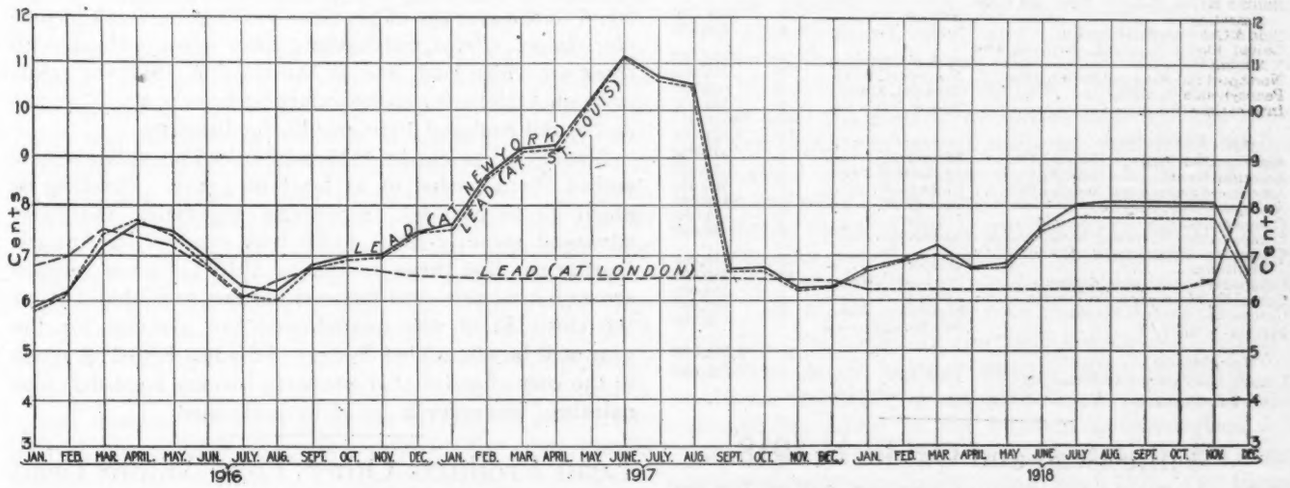
Month	New York			St. Louis			London		
	1916	1917	1918	1916	1917	1918	1916	1917	1918
January	5.921	7.626	6.782	5.826	7.530	6.684	31.167	30.500	29.00
February	6.246	8.636	6.973	6.164	8.595	6.899	31.988	30.500	29.00
March	7.136	9.199	7.201	7.375	9.120	7.091	34.440	30.500	29.00
April	7.630	9.288	6.772	7.655	9.158	6.701	34.368	30.500	29.00
May	7.463	10.207	6.818	7.332	10.202	6.704	32.967	30.500	29.00
June	6.936	11.171	7.611	6.749	11.123	7.511	31.011	30.500	29.00
July	6.352	10.710	8.033	6.185	10.644	7.750	28.137	30.500	29.00
August	6.244	10.594	8.050	6.088	10.518	7.750	29.734	30.500	29.00
September	6.810	8.680	8.050	6.699	8.611	7.750	30.786	30.500	29.00
October	7.000	6.710	8.050	6.898	6.650	7.750	30.716	30.500	29.00
November	7.042	6.249	8.050	6.945	6.187	7.750	30.500	30.500	31.20
December	7.513	6.375	6.564	7.405	6.312	6.324	30.500	30.500	40.00
Year	6.858	8.787	7.413	6.777	8.721	7.222	31.359	30.500	30.10

New York and St. Louis, cents per pound. London, pounds sterling per long ton.

really a mistake, for the statistical position of the metal was strong, and, asserting itself, the market advanced rapidly. By the middle of June there was no doubt in the mind of anybody respecting the stringency of the situation. At the request of the War Industries Board a lead producers' committee, under the chairmanship of Clinton H. Crane, was organized to take charge of the business. However, the War Industries Board would not permit the price to go above 7¾c. New York. While there was no formal fixing of price, to all intents and purposes there was. The only difference between the situations in lead and copper was the absence of formal hearings, agreements, etc., which made it easier to negotiate modifications when necessary. Indeed, one modification became immediately necessary owing to the advance in freight rates on July 1, following which the

price for lead was raised to 8.05c., New York, compensating for the increase in freight rate. That price prevailed until Dec. 20.

The only way of handling the business in the second half of 1918 was to put consumers practically on a ration basis and curtail non-essential consumption so far as possible. The producers put their output into the hands of the committee, which received the orders from consumers and attended to the distribution, which was prorated among the producers. Earlier in the year there had been a strong demand for lead from foreign quarters. Exportation was now practically forbidden, except with respect to that which was refined from Mexican bullion. The bulk of the latter was taken by the British government in private contract with the two principal producers, and in the latter part of 1918 the whole of it was so taken. The British did very well on these contracts, having made the larger one


LEAD (AT NEW YORK)
LEAD (AT ST. LOUIS)
LEAD (AT LONDON)
Cents
JAN. FEB. MAR. APRIL. MAY. JUN. JULY. AUG. SEPT. OCT. NOV. DEC. JAN. FEB. MAR. APRIL. MAY. JUNE. JULY. AUG. SEPT. OCT. NOV. DEC. JAN. FEB. MAR. APRIL. MAY. JUNE. JULY. AUG. SEPT. OCT. NOV. DEC.
1916
1917
1918

MONTHLY AVERAGE PRICES OF LEAD—1916, 1917, 1918.

when lead was at a very low price, while they did not pay higher than 8.05c., New York, for anything.

With the signing of the armistice on Nov. 11, the lead producers found themselves in a better position than the copper producers, for they had proportionally more orders on their books, and also had a good many of their old average-price contracts. However, the cancellation of orders caused lead to back up on the hands of manufacturers, and the producers themselves received more or less cancellations. Furthermore, the stock of lead in the hands of the Government was promptly seen to be a menace.

At the request of the War Industries Board, the Committee of Lead Producers continued in service and for a few weeks maintained its price at 8.05c., after which the price was reduced to 7.05c. Small business was received at those prices from random quarters where supplies happened to be inadequate, but the total of this business was only a few hundred tons per week. Most of the lead producers curtailed their production immediately after the armistice, but one of them failed to do so. This produced technical reasons that compelled a dissolution of the committee on Dec. 20, and on the following day lead was offered in tonnage at 6c. and then 5¾, 5½, and 5¼c., without developing any large business. The largest producers reduced their asking price to 6c., but did not follow the market all the way down. At the close of 1918 there were signs that the market might rally to about 5¾c., our closing quotation being 5¼@5¾ cents.

In Great Britain the price for lead was fixed officially at £29 on Jan. 2, 1918, and continued at that figure until Nov. 26, when it was raised to £40. The British government bought lead from Australia, Spain, and Mexico. the cost of which was more than £29 in England, but the government pocketed the loss in distribution at that price. The advance to £40 was evidently to correct that condition in so far as the liquidation of the large governmental stock was concerned. American producers would immediately have broken that price with offerings of their lead, but they could not obtain transportation for it.

The close of 1918 sees very large stocks of pig lead all over the world. There is about 50,000 tons in the hands of the producers and the contractors for the United States, 55,000 tons in the possession of the Ministry of Munitions in Great Britain, 8000 tons at Trail, B. C., a further large quantity in the hands of the Canadian government and supposedly a large supply in Australia. Probably there is 250,000 tons of pig lead in the hands of producers and governments throughout the world.

Silver-Lead Smelting Works of North America

The accompanying list, which has been corrected to Dec. 1, 1918, gives the several silver-lead smelting works of the United States, Mexico, and Canada, together with the number of their furnaces (in all cases, blast furnaces) and their estimated annual capacity in tons of charge. By "tons of charge" is meant ore and flux, but not coke. The ton of charge is manifestly the correct unit. In the case of a self-fluxing ore, the ton of ore smelted and the ton of charge smelted is the same thing. In other cases fuel and labor have to be used in smelting the flux as well as in smelting the ore, and the economy of smelting depends largely upon the percentage of ore in the charge. The management of this question is about the highest exercise of the metallurgist's skill.

The figures in the accompanying table are in most cases from official communications of the respective

companies. Estimated capacity is always a matter of more or less uncertainty, and for this reason the figures given should be accepted only as approximations.

The total capacity of the Mexican works at the end of 1918 is a little over 2,300,000 tons per year; of the American works, about 5,521,000 tons. With respect to the American works, such capacity has never been in use at one time. More or less of it represents capacity idle because of changes in the conditions of ore supply.

AMERICAN SILVER-LEAD SMELTING WORKS

Company	Place	Furnaces	Annual Capacity(a)
American Smelters Securities Co. (Selby Works)	Selby, Calif.	3	210,000
American Smelting and Refining Co.	Denver	7	510,000
American Smelting and Refining Co.	Pueblo	7	380,000
American Smelting and Refining Co.	Durango	4	210,000
American Smelting and Refining Co.	Leadville	10	510,000
American Smelting and Refining Co.	Murray	8	657,000
American Smelting and Refining Co.	East Helena	4	306,000
American Smelting and Refining Co.	Omaha (b)	2	82,000
American Smelting and Refining Co.	Perth Amboy (b)	4	170,000
Con. Kansas City Sm. and Ref. Co.	El Paso	6	380,000
Bunker Hill & Sullivan Min. and Concentrating Co	Kellogg, Ida	3	600,000
Ohio & Colorado Smelting Co	Salida, Colo.	3	200,000
United States Smelting, Refining and Mining Co.	Midvale, Utah	7	530,000
Northport Smelting and Refining Co.	Northport, Wash.	2	216,000
Pennsylvania Smelting Co.	Carnegie, Penn.	2	60,000
International Smelting Co.	Tooele, Utah	5	500,000
Totals, United States		77	5,521,000
American Smelting and Refining Co.	Monterrey	7	410,000
American Smelting and Refining Co.	Aguascalientes	1	40,000
American Smelting and Refining Co.	Chihuahua	7	400,000
American Smelters Securities Co.	Velardeña	3	150,000
Compañia de Minerales y Metales	Cerralvo	2	35,000
Compañia de Minerales y Metales	Guadalupe, N. L.	1	70,000
Compañia Fundidora y Afinadora de Monterrey	Monterrey	4	210,000
Compañia Metalurgica Mexicana	San Luis Potosi	10	250,000
Compañia Metalurgica de Torreon	Torreon	9	350,000
Compañia Minera de Peñoles	Mapimi	6	350,000
Mazapil Copper Co	Saltillo, Coah.	1	36,000
Totals, Mexico		51	2,301,000
Consolidated Mining and Smelting Co.	Trail, B. C.	4	98,680

(a) Tons of charge. (b) Smelt chiefly refinery between-products.

White Lead and Oxides in 1918

The decline in the price of pig lead during the last three months of 1917 was so clearly not justified by actual trade conditions that manufacturers made no reduction on dry pigments after Oct. 19 of that year, and the prices then established continued in force until May 28, 1918.

Dry white lead opened at 9c. per lb. in a large way, but, following the upward course of pig lead, advanced ¼c. on May 28, and there were further advances of ¼c. on June 21 and ¼c on July 24, making the price 10c., which continued in force until the close of 1918.

For many years the margin allowed large dealers in white lead in oil had been ¼c. per lb., and though this was accepted as reasonable on a staple of this class when the list price ranged at 7c. or under, it became unprofitably small when the price reached 12c. or more, and corroders, therefore, adopted a system of pricing which gave to all classes of dealers a more liberal profit, based on percentages instead of upon a specified rate per pound. The schedule adopted Apr. 26 established a base price of 12¼c. per lb. for 100 lb. packages, with a discount of 10% on quantities of 500 to 2000 lb.; 10 and 2½% on 2000 to 10,000 lb.; 10 and 5% on 10,000 to 30,000 lb., and 10 and 6% on 30,000 lb. or over. This made the minimum price to largest buyers 10.36c. against 10¾c. as the opening price under the old system. There were subsequent advances in May, June, and July, which brought the base price to 14c. on July 28, giving a net price of 11.84c. to largest buyers, or practically 1c. above the opening price of the year, although pig lead had meantime advanced 1.80c. It is expected that future fluctuations will apply only to the base price, leaving the scale of discounts unchanged.

Sales of dry white lead to paint manufacturers, and of lead in oil to painters, were considerably below any previous year for a long period, owing chiefly to the effect which war conditions had in restricting building operations everywhere. There was little new work except Government construction, and the difficulty in obtaining labor, as well as its high cost, added to that of lead and linseed oil, caused a neglect of old work which would have been repainted under normal conditions.

The demand for oxides has been large. The Government required the use of enormous quantities of red lead on ships and other structures, and the industries using red lead and litharge have all been large consumers, so that sales of these products have been fully equal to the average of previous years going back to prewar dates. Price fluctuations have synchronized with those on white lead, and at the close of 1918 the minimum quotations for casks to largest buyers are 11¼c. per lb. for red lead and 10¾c. per lb. for litharge.

Linseed-oil prices in 1918 established an entirely new record for a period of at least 60 years. Starting at about $1.30 per gal. in jobbing quantities, the price advanced steadily until $1.90 was reached in August. During the last three months of 1918 the price receded somewhat as new-crop flaxseed became available, but, at the close, $1.58 was quoted, and the average for the year will be about that figure. This has added so much to the cost of paint that property owners have deferred painting, wherever it could be postponed.

Lead Products Other Than White Lead

BY J. R. WETTSTEIN*

Reviewing the industry of lead products other than white lead in 1918, it is significant to note the wide dissimilarity between the normal demand of these products and the demand created by the war. A lead shortage, threatened through the greater part of the year, made it necessary for the authorities in Washington to adopt measures confining the use of lead to the actual needs of the Government for the successful prosecution of the war. As was to be expected under such conditions, it soon developed that, with few exceptions, most of the products of lead were highly essential to the Government's requirements, both direct and indirect. Therefore the record of business for the year will represent a war demand with which comparison in peace times reveals nothing, except, perhaps, emphasizing the fact that war demands for lead products greatly overshadow the normal demands of peace.

Mixed Metals—These comprise babbitts, solders, and casting metals, and alloys of lead, tin, and antimony, used for the most part industrially. The demand for these products was particularly strong throughout 1918, reflecting the continued demand upon industry and transportation speeded to the utmost by governmental requirements. Although the preceding year was a record breaker in point of tonnage, mixed-metal products in the year just closed will undoubtedly show quite as large

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if not a larger business than the year before. Since the armistice, the tonnage has shown signs of diminishing, and 1919 will probably exhibit a considerable shrinkage, depending altogether upon how easily the industries of the country return to their pre-war condition. At one time famine conditions existed in tin, which might have led to the enforced curtailment of the demand for bearing metals were it not for the fact that other metals and alloys were in a large degree substituted for tin.

Oxides of Lead—These products, used principally in the form of red lead and litharge in the glass and rubber manufacturing business, and for painting material, record a continuance of the heavy demand of 1917. The business done was probably larger than that of 1917, even though exports were embargoed for some time, owing to the extreme scarcity of lead for a large part of the year. In adjusting themselves to peace conditions these materials will undoubtedly also show a shrinkage in volume.

Shot—Because of the high price of loaded shotgun shells, in the making of which practically all the shot manufactured in the country is used, the tonnage of shot will probably be found to be smaller for 1918 than for any previous year of which there is a record. For a time the industry was threatened with a complete cessation because of the great scarcity of lead and its vital need for purposes more directly connected with the war. The industry was looked upon as non-essential, though a moderate tonnage was taken by the Government in the form of shot-shells for practice work among the recruited troops. The product will probably adapt itself to a normal demand much more rapidly than most of the other products of lead, as a desire to excel in marksmanship has undoubtedly been greatly stimulated by the war.

Lead Pipe—By reason of the Government restriction on building trades, the confining of new construction to the necessary building of plants and the housing of employees, and the discouragement of ordinary public works under municipal guidance, the normal demand for pipe shrank to figures not seen for many years. Its use in manufacturing enterprises, chemical plants and shipbuilding increased rapidly during 1918, so that the total tonnage for the year was not far below normal in point of output. Not much recovery in the normal demand can be expected until a normal condition in the building trades has been completely restored.

Sheet Lead—This product in 1918 came under the Government demand for shipbuilding, acid and powder plants, and industrial purposes generally, which demand was also keenly in evidence during 1917. Indications point to a somewhat larger tonnage for 1918, although the makers of the commodity were probably driven to greater capacity, owing to the fact that a component part of a high-explosive shell—a lead disk—was manufactured at the mills. The over-expansion in the erection of acid and powder plants occurring in the last two or three years will undoubtedly make itself felt by a much lessened demand during the next few years.

Munitions—A large tonnage of an alloy composed of 87½% lead and 12½% antimony found its way into shrapnel balls in 1918. Though complete figures are not yet available, the consumption of lead for this purpose was probably twice as large as during the year before. It is not far off the mark to say that fully 75,000 tons of lead was consumed in the country for this purpose during the last four years. The close of 1918 finds practically all orders for shrapnel balls completed, and such as are in large part unfinished have probably been canceled by the Government, so that the demand for this product is satisfied, and, let it be hoped, for all time.

The Coeur d'Alene District in 1918

BY STANLY A. EASTON*

The beginning of the year 1918 was marked by unprecedented floods, which cut off for a period of nearly two weeks all railroad communication serving the western part of the district, and did great damage to the new and partly constructed Pine Creek branch of the Oregon-Washington R. & N. Co., which has since remained unfinished and in a damaged condition, and also washed out the recently constructed branch up Beaver Creek on the North fork of the Cœur d'Alene River, serving a portion of the Sunset Peak country, so that no railroad service was possible for months. These troubles, together with the scarcity of skilled labor and the shortage and expense of mining material, practically stopped production and development operations in the Pine Creek and other outlying parts of the district.

Later in the year, the operation of the selective draft, volunteering for the service in considerable numbers, and the lure of other war industries, took many workmen, both single men and men with families, from the district. Still later in the year the Spanish influenza epidemic caused further serious labor shortages. In addition, the difficulty and expense of securing all kinds of supplies added to the burdens of production. In spite of these difficulties, the mines of the Cœur d'Alenes produced with regularity throughout 1918, and though the output of lead, silver, and zinc, which cannot at this time be even reasonably estimated, will doubtless be lower than in 1917, it surely will not fall below the average maintained for the last five years.

The Bunker Hill smeltery and refinery at Kellogg ran continuously throughout 1918. A notable production of refined desilverized lead, refined silver, and gold and copper sulphate was made from the ores of the Bunker Hill and affiliated mines and from the ores of the Hecla Mining Co. The copper-sulphate product is utilized in the flotation plants of the district.

An additional bonus of 50c. per shift so long as New York lead is 8c. per lb. or higher was granted on July 10 by the various companies to all employees of the district. The total bonus thus amounted to $1.75 per shift.

Some copper production is made from the National and Caledonia mines, but there is no immediate promise of a greater copper output. Since the early 80's, when the placers of the North side, on Prichard Creek, at Murray, flourished, Shoshone County had made no considerable gold yield until 1918. During 1918 the dredge of the Yukon Gold Co. handled 4000 cu.yd. per day of Prichard Creek gravels, and gave a gold yield the amount of which is not available, but which is known to be substantial.

The war record of the Cœur d'Alene district, ex-

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pressed in its financial responses to the needs of the Government and the Army, may well find a place in an account of its activities. The allotment and actual subscriptions to the Government loans and to Red Cross and like campaigns follow:

WAR DRIVES IN THE COEUR D'ALENE DISTRICT

Allotment	Subscription	Allotment	Subscription
First Liberty Loan (No record available)		First Red Cross Drive $50,000	$53,000
Second Liberty Loan $810,000	$1,667,000	Second Red Cross Drive 32,000	52,000
Third Liberty Loan 850,000	1,227,000	United War Work Drive 40,000	48,000
Fourth Liberty Loan 850,000	1,405,000		

Miscellaneous subscriptions follow: Y. M. C. A., $14,000; Knights of Columbus $4000; Salvation Army, $3500; Y. W. C. A., $4000; War Savings Stamps (to date), $270,000.

It is thus apparent that the citizens as well as the mines have stood the test of war times. There was no break in production or shortage of products from the Cœur d'Alene mines throughout the entire period of the Great War.

British Imports and Exports

The following figures of British metal imports and exports (except exports for use of British forces on active service) have been reported by the Board of Trade, and published in the *Ironmonger*, of Dec. 14, 1918:

BRITISH IMPORTS, FIRST 11 MONTHS
(In Long Tons)

Metals	1917	1918
Pig iron, basic	31,848	53,823
Pig iron, forge, foundry	72,629	27,113
Pig iron, hematite	15,353	9,832
Pig iron, other grades	12,585	23,288
Steel blooms, etc	58,227	20,014
Iron bars, angles, rods	60,087	23,714
Copper regulus	24,294	20,081
Copper, unwrought and part wrought	123,511	191,737
Lead, pig and sheet	133,609	194,081
Tin, blocks, ingots, etc	25,624	11,770
Zinc, crude	68,051	58,315
Zinc, manufactured	4,023	2,495

BRITISH EXPORTS, FIRST 11 MONTHS
(In Long Tons)

Metals and Ores	1917	1918
Pig iron	704,047	455,285
Basic	10,751	12,319
Forge and foundry	314,085	222,235
Hematite	288,021	157,696
Other grades	91,190	63,035
Iron ore	667	160
Copper	9,911	6,933
Ingots, etc	4,980	4,031
Yellow and mixed	482	199
Manufactures of	3,348	2,267
Lead, pigs, etc	9,006	4,168
Tin, unwrought	17,790	14,529
Zinc and spelter	7,771	1,330

Quicksilver in California

BY MURRAY INNES*

The quicksilver output of California in 1918 is estimated at 23,000 flasks, as against 24,251 flasks in 1917 and 21,045 flasks in 1916. The decline in production was due partly to the closing down of some of the smaller mines, and was accentuated by the sudden drop in production of the New Idria mine in the last quarter of the year. That mine made a record production during the summer of 1918, attributable in part to the treatment of a large tonnage of old dumps and surface material, which was handled mainly by concentration. Toward the end of the year these old mining dumps were partly exhausted, resulting in a notable drop in the New Idria output.

As in recent years, the New Idria mine accounted for about half of the California output, the rest being divided between about 15 smaller producers, which struggled with steadily increasing operating expenses, owing to labor scarcity and inefficiency and the high cost of supplies common to all Western mining ventures during the year. In general, the actual cost of producing quicksilver in California exceeded $80 per flask in 1918, without taking into consideration depreciation or depletion, which items most quicksilver mines have in the past been too likely to overlook.

The average cost of producing the metal having at least doubled in the last four years, the immediate outlook for the California quicksilver producer is anything but encouraging. The supply of low-grade ore is ample and it is extremely probable that active development work, such as has been carried on recently, would develop ores of better grade. Both the metallurgical and the mining practices are now entirely up to date in the principal quicksilver mines of the state, and, had they a fair chance in the matter of labor and other costs, some of them might now hold their own in competition with the European producers, but with costs ranging at anything like present figures this seems impossible.

The dumping of the surplus output of Europe put an end to the profitable production of quicksilver in California prior to 1914, and the producers have now every reason to fear a renewal of the dumping process. Their costs, as stated, having doubled in the last four years, they are now much more vulnerable to foreign competition, and though a few of the mines might continue to operate for a time even at a loss, the outlook is for a considerably reduced production of quicksilver in 1919.

Several of the smaller mines recently shut down, including the Sulphur Bank, in Lake County; the Aetna mine, in Napa County, and also the Abbott, La Joya, Big Injun, and the Socrates properties, and I am informed that some of the larger producers are seriously considering doing likewise.

As stated, the narrow policy of the United States Government in the matter of tariff ruined this once-important industry before the war, but the quicksilver producers have now some slight hopes that such essential metals will receive consideration. It would seem that the country should have learned the wisdom of having available all the essentials of national defense, particularly the raw materials and metals, and that it would be most unwise to destroy this industry again when a protective tariff would insure a supply sufficient for home consumption. A thorough investigation by the United States Tariff Commission and by the War Trade Board has demonstrated that only by a high tariff can the California producers now hope to compete with the foreign product.

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Alaska Mines Produced Gold to the value of about $10,000,000 in 1918, compared with $14,650,000 in 1917, according to the U. S. Geological Survey. The total value of gold mined in the territory is now about $302,000,000, of which $213,500,000 has been won from placers. In 1918, about 69,400,000 lb. of copper was produced in Alaska. The production in 1917 was 88,793,000 lb. The total copper produced to date is 499,000,000 lb. The value of Alaska's lesser mineral products in 1918 was as follows: Silver, $870,000; coal, $435,000; tin, $90,000; lead, $85,000; miscellaneous metallic products, including chrome ore, tungsten, palladium, platinum, and antimony, $117,000; and miscellaneous non-metallic products, $120,000.

Zinc

THE accompanying statistical tables show clearly the record of production in the United States. During the first quarter curtailment of production was the order of the day. The full effects of this were seen in the second quarter. Thereafter, production was fairly steady, and although much less than in 1917 was large in comparison with the maximum pre-war year. In the latter part of 1918 the predominant feature was the pressure of the electrolytic producers, who made a steadily increasing output. The spelter producers had an unsold stock throughout 1918, and although it diminished in the second half there was considerable doubt whether metal was not simply passing from visible into invisible supply. The stock of spelter in hands of producers on Dec. 31 was 40,325 tons, compared with 60,415 tons at the beginning of the year.

SPELTER PRODUCTION, 1913–1918, BY QUARTERS

(In Tons of 2000 Lb.)

Reports of Ore Smelters Only

District	I	II	III	IV
1913				
Illinois	27,924	28,523	26,118	28,986
Kansas-Missouri	22,006	23,820	19,204	20,127
Oklahoma	21,430	21,840	18,502	21,458
Others (a)	20,722	20,153	19,238	18,211
Totals	92,082	94,336	83,062	88,782
1914				
Illinois	31,005	32,482	32,512	34,588
Kansas-Missouri	13,939	14,659	13,193	11,633
Oklahoma	22,563	22,960	22,945	23,999
Others (a)	22,717	22,715	24,106	24,296
Totals	90,224	92,816	92,756	94,516
1915				
Illinois	35,786	39,511	41,791	44,577
Kansas-Missouri	14,090	24,554	32,152	40,256
Oklahoma	24,713	26,984	28,613	31,095
Others (a)	26,255	30,575	31,360	34,830
Totals	100,844	121,624	133,916	150,758
1916				
Illinois	45,344	45,547	41,953	48,651
Arkansas	.....	.....	2,977	4,660
Kansas-Missouri	38,513	42,488	39,447	33,948
Oklahoma	34,994	38,786	42,604	52,680
Others (a)	37,853	39,873	41,514	48,186
Totals	156,704	166,694	168,495	188,125
1917				
Illinois	48,756	47,237	40,379	39,699
Arkansas	5,597	6,847	7,596	5,661
Kansas-Missouri	26,350	25,621	19,443	15,091
Oklahoma	53,280	57,227	48,478	45,602
Electrolytic	7,950	8,362	5,096	5,837
Others (a)	42,013	41,700	39,736	38,853
Totals	183,946	186,994	160,728	150,743
1918				
Illinois	35,297	34,829	36,448	34,787
Arkansas	6,157	5,603	7,629	7,317
Kansas-Missouri	10,284	5,015	7,198	9,526
Oklahoma	38,171	34,999	35,192	34,752
Electrolytic	8,088	9,405	11,037	10,568
Others (a)	36,881	36,265	35,445	34,229
Totals	134,878	126,116	132,949	131,179

(a) With the exception of one plant in Colorado, these are all Eastern works. In the fourth quarter of 1915 and in 1916 is included Anaconda and other electrolytic production.

The fundamentals in the zinc business of the United States are not encouraging. At the middle of 1918, after the weaker smelters had discontinued business, probably forever, there remained among the strong and active concerns capacity for producing 800,000 tons of spelter per annum, of which capacity they were able to use only about five-eighths. The capitalization of the idle capacity was estimated at $10,000,000. A similar situation existed with respect to mining and milling plants, of which the unused part was also estimated at $10,000,000. The direct cost of smelting in a large part of the plants had increased by something like 1½ to 2 times, while the percentage of zinc extraction had diminished from an average of about 86% to something like 82%. The lot of the smelter was not therefore a happy one. The cost of mining had similarly increased in the Joplin district, but it was offset more or less by the mining of relatively rich ore in Oklahoma. The price of ore therefore declined relatively more than the price for spelter. Dissatisfaction over this condition led to a pooling arrangement being formed in October, but it was so uneconomic in its idea that it was bound to blow up, which, in fact, it did speedily. At the end of 1918 there was a large surplus of ore, which was salable only with difficulty, but the declining tendency in the spelter market indicated the approach of the day of curtailment both in mining and smelting, which would be the natural corrective.

American spelter producers have been looking for a revival of the export trade, but the prospect does not seem immediate. There was indeed a certain demand in November, which was met by the producers of high-grade metal. At about that time the British Munitions Ministry reported holding 18,769 long tons of common spelter and 6544 tons of high grade. France professed to have ample supplies. Indeed, the attitude of both the British and French governments was toward disposing of their holdings before letting any more foreign spelter in.

PRODUCTION OF SPELTER

(In Tons of 2000 Lb.)

By Ore Smelters Only

States	1914	1915	1916	1917	1918
Arkansas	.....	.....	7,637	25,701	26,706
Colorado	8,152	8,984	8,908	7,735	3,890
Illinois	130,587	161,665	181,495	176,071	141,361
Missouri-Kansas	53,424	111,052	154,396	86,505	32,023
Oklahoma	92,467	111,405	169,064	204,587	143,114
Electrolytic	.....	.....	10,963	27,245	39,098
East and others (a)	85,682	114,036	147,555	154,567	138,930
Totals	370,312	507,142	680,018	682,411	525,122

(a) Includes Anaconda and other electrolytic production in 1915.

EXPORTS DURING FIRST TEN MONTHS

	1916	1917	1918
Zinc ore, long tons	70	924	55
Zinc dross, lb	56,525	20,475,301	26,367,994
Pigs, plates, slabs, etc.:			
From domestic ore, lb	237,256,165	228,573,972	106,945,345
From foreign ore, lb	72,021,299	112,500,809	33,876,062
Sheets, strips, boiler plates, etc., lb.	19,734,045	27,907,238	21,593,074

IMPORTS DURING FIRST TEN MONTHS

	1916	1917	1918
Zinc ore and calamine, gross weight, long tons	297,311	175,284	56,168
Zinc contents, lb	252,951,201	135,668,774	44,480,267
Blocks or pigs and old, lb	1,192,657	387,447	70,246
Zinc dust, lb	1,686,665	732,647	23,046

Australia made an increased production of spelter in 1918, and Spain a decreased, but the output of those countries is small. During the first eight months Japan exported only about half the spelter it did in the corresponding period of the previous year. Whether this indicates diminished production, accumulation of stock, or both, we do not know. The production of British smelters in 1918 will be about 55,000 long tons. The great new smeltery at Avonmouth was not finished, nor were extensions to other plants, but these should be completed in 1919, and it is estimated that Great Britain's capacity for producing spelter at the end of 1919 will be 130,000 tons.

The electrolytic plant at Risdon, in Tasmania, is to be greatly increased in capacity, and new plants of considerable size are to be built in France (Pyrenees) and in Italy, but there is no expectation that any of these will be producers in 1919. Nor will be the new distillery of 25,000 tons' annual ore capacity of the Burma Mines, Ltd., at Sackchi, in India.

Recent reports to us from Belgium were that the smelting works of that country were not materially damaged, but it will be an indeterminate time before some of those along the Meuse can resume operations. However, some of the Belgian plants, including Overpelt and Lommel, in the Campine, were operated during the occupation.

The Dutch and French plants, except those in the coal fields of Northern France, are probably in a position to make their usual production as soon as they can be supplied with adequate ore and fuel. The smelteries of Rheinland and Westphalia are mainly within the zone of occupation. The zinc-mining and smelting district of Upper Silesia, near the Polish frontier, is now the scene of Polish advance, with consequential disorder.

The Zinc Market in 1918

At the beginning of 1918 common spelter was quoted at 7⅜c. St. Louis. There was an overproduction and stocks were accumulating. The statistical conditions caused a decline in the market to 6.60c. That relatively low price, which was estimated to be equivalent to about 3¾c. before the war, caused a general closing of inefficient smelteries. Many of these were abandoned, and not a few were dismantled.

The curtailment of production was overdone, in view of the continued large requirement of spelter for brass making, and the market price rallied to about 8½c. at the beginning of July. After a minor setback, further improvement in the statistical position advanced the price to 9⅝c. in September, but with this advance the margin between common and high-grade spelters contracted, and eventually it ceased to be profitable to refine by redistillation. The supply of common spelter for sale being thus increased, the market started on a slow but steady decline. The advent of the armistice did not produce in zinc just the same conditions as in copper and lead, for zinc had never been under control. However, the weakness of the market became a little more pronounced, and 1918 closed with the quotation of 7.45 cents.

At the beginning of 1918 high-grade spelter was quoted in the neighborhood of 12½c. During the spring the War Industries Board fixed 12c. as a maximum price. A little later, an alteration in the Army specifications increased the supply of high-grade metal. The market becoming more competitive, the price declined below 12c. Toward the close of 1918 high-grade metal was sold at 9c., and at the very end of the year it is doubtful if it were properly quotable above 8½ cents.

The prices of sheet zinc and rolled plate were fixed at 15 and 14c., respectively, and those prices were maintained until the end of 1918, the supply being steadily short, because of insufficient manufacturing capacity. Owing to the large profit that those prices permitted, the producers of special grades of ore in the Joplin district claimed a participation in it and obtained a fixed price of $75 per ton, the requirements of the sheet zinc producers being prorated among those ore producers.

MONTHLY AVERAGE PRICE OF SPELTER

	New York			St. Louis			London		
Month	1916	1917	1918	1916	1917	1918	1916	1917	1918
Jan.	16.915	9.619	7.836	16.745	9.449	7.661	89.810	48.329	54.000
Feb.	18.420	10.045	7.814	18.260	9.875	7.639	97.762	47.000	54.000
Mar.	16.846	10.300	7.461	16.676	10.130	7.286	95.048	47.000	54.000
Apr.	16.695	9.459	6.890	16.525	9.289	6.715	99.056	54.632	54.000
May	14.276	9.362	7.314	14.106	9.192	7.114	94.217	54.000	54.000
June	11.752	9.371	8.021	11.582	9.201	7.791	68.591	54.000	54.000
July	8.925	8.643	8.688	8.755	8.473	8.338	50.750	54.000	54.000
Aug.	8.730	8.360	8.985	8.560	8.190	8.635	51.587	54.000	54.000
Sept.	8.990	8.136	9.442	8.820	7.966	9.092	52.095	54.000	54.000
Oct.	9.829	7.983	8.801	9.659	7.813	8.451	54.159	54.000	54.000
Nov.	11.592	7.847	8.491	11.422	7.672	8.141	56.023	54.000	54.100
Dec.	10.665	7.685	8.163	10.495	7.510	7.813	55.842	54.000	56.050
Year.	12.804	8.901	8.159	12.634	8.730	7.890	72.071	52.413	54.180

New York and St. Louis, cents per pound. London, pounds sterling per long ton.

AVERAGE PRICE OF ZINC SHEETS

(In Cents per Pound)

	1916	1917	1918		1916	1917	1918		1916	1917	1918
Jan.	23.40	21.00	19.00	May.	24.00	19.00	15.00	Sept.	15.00	19.00	15.00
Feb.	24.50	21.00	18.00	June.	19.50	19.00	15.00	Oct.	15.20	19.00	15.00
Mar.	25.00	21.00	15.00	July.	15.60	19.00	15.00	Nov.	18.25	19.00	15.00
April.	25.20	20.44	15.00	Aug.	15.00	19.00	15.00	Dec.	21.00	19.00	15.00

Average for the year 1916—20.14 cents, 1917—19.62 cents, 1918—15.58 cents.

Note—These are base prices for ordinary size sheets, in carload lots, f. o. b. La Salle-Peru, Ill., less 8% discount.

ZINC-SMELTING CAPACITY OF THE UNITED STATES

(Number of Retorts at End of Years)

Name	Situation	1917	1918
American Spelter Co. (a)	Pittsburg, Kan.	896 (d)	896
American Steel & Wire Co	Donora, Penn.	9,120	9,120
American Zinc and Chem. Co. (a)	Langeloth, Penn.	7,296	7,296
American Zinc Co. of Ill.	Hillsboro, Ill.	4,864	4,864
American Zinc, Lead and Smg. Co.(a)	Dearing, Kan.	4,480 (e)	.....
American Zinc, Lead and Smg.Co.(a)	Caney, Kan.	6,080 (f)	6,080
American Zinc, Lead and Smg. Co. (a)	Neodesha, Kan.	3,760 (e)	.....
American Zinc, Lead and Smg. Co.	E. St. Louis, Ill.	5,620	5,620
Arkansas Zinc and Smelting Corpn	Van Buren, Ark.	3,200	3,200
Athletic Min. and Smelting Co.	Fort Smith, Ark.	1,664	2,496
Bartlesville Zinc Co.	Bartlesville, Okla.	5,184	7,488
Bartlesville Zinc Co.	Blackwell, Okla.	9,600	9,600
Bartlesville Zinc Co.	Collinsville, Okla.	13,400 (i)	13,400
Bartlesville Zinc Co., Lanyon-Starr	Bartlesville, Okla.	3,456	3,456
Collinsville Zinc Co. (a)	Collinsville, Ill.	1,984 (d)	1,984
Eagle-Picher Lead Co.	Henryetta, Okla.	3,000	4,000
Edgar Zinc Co.	Carondelet, Mo.	1,982 (e)	.....
Edgar Zinc Co.	Cherryvale, Kan.	5,040	5,040
Fort Smith Spelter Co.	Fort Smith, Ark.	2,560	2,560
Grasselli Chemical Co.	Clarksburg, W. Va.	5,760	5,760
Grasselli Chemical Co.	Meadowbrook, W. Va.	8,520	8,520
Grasselli Chemical Co.	Terre Haute, Ind.	3,360	4,200
Hegeler Zinc Co.	Danville, Ill.	5,400	5,400
Henryetta Spelter Co.	Henryetta, Okla.	(a) 3,000 (b)	3,000
Illinois Zinc Co.	Peru, Ill.	(b) 4,640	5,440
J. B. Kirk Gas and Acid Co. (a)	Iola, Kan.	3,440 (b)	3,440
Kusa Spelter Co.	Kusa, Okla.	7,520	5,360
Lanyon Smelting Co.	Pittsburg, Kan.	(d) 448 (d)	448
Robert Lanyon Zinc and Acid Co.	Hillsboro, Ill.	3,200	3,200
Matthiessen & Hegeler Zinc Co.	La Salle, Ill.	6,168	6,168
Mineral Point Zinc Co.	Depue, Ill.	9,068	9,068
National Zinc Co.	Bartlesville, Okla.	4,256	4,160
National Zinc Co.	Springfield, Ill.	4,480	4,480
New Jersey Zinc Co. of Penn.	Palmerton, Penn.	7,200	7,200
Oklahoma Spelter Co.	Kusa, Okla.	(d) 1,600 (d)	1,600
Owen Spelter Co.	Caney, Kan.	1,920 (d)	1,920
Pittsburg Zinc Co.	Pittsburg, Kan.	(d) 910 (d)	910
Prime Western Spelter Co.	Gas and Iola, Kan.	4,866 (g)	1,972
Quinton Spelter Co.	Quinton, Okla.	2,016	2,016
Sandoval Zinc Co.	Sandoval, Ill.	672	672
Tulsa Fuel and Manufacturing Co.	Collinsville, Okla.	6,232	6,232
United States Smelting Co. (a)	Altoona, Kan.	4,640 (e)	.....
United States Smelting Co.	Checotah, Okla.	5,120 (i)	5,120
United States Zinc Co.	Henryetta, Okla.	2,400	3,448
United States Zinc Co.	Sand Springs, Okla.	8,000	7,560
United States Zinc Co.	Pueblo, Colo.	2,200	2,208
United Zinc Smelting Corpn.	Moundsville, W. Va.	1,728	1,728
United Zinc Smelting Corpn.	Clarksburg, W. Va.	3,648 (i)	3,648
Weir Smelting Co. (h)	Weir, Kan.	(a) 448 (d)	448
Totals		216,046	202,426

(a) Closed during latter part of 1917. (b) No report received; entered the same as previous year. (c) Dismantled. (d) Idle all year. (f) Part (4 blocks) leased to Weir Smelting Co. (g) The plant at Gas City was wrecked by cyclone, March, 1918. (h) Weir Smelting Co. is operating 4,384 retorts of the Caney plant of American Zinc, Lead and Smelting Co. (i) Idle latter part of 1918.

Lead and Zinc in the Joplin District

BY JESSE A. ZOOK*

At the close of 1918 about 30 mills were operating in Jasper County, Mo., not counting those of the Waco camp, and not all of these steadily. All others have been removed, some into Kansas, opposite Waco; some into Kansas, opposite Picher, Okla.; and many into the northern part of Ottawa County, Oklahoma.

Shipments of blende from Jasper County attained the zenith in March, 1918, with 14,605 tons, and dropped to 4932 tons in November. Calamine shipments, only 424 tons in March and 644 tons in June, rose to 680 tons in November. Lead shipments fell from 2335 tons in March to 1526 tons in June and 1076 tons in November. Some revival is noted around Duenweg, where

TABLE I. ORE PRICES IN THE JOPLIN DISTRICT FOR 11 YEARS
(Per Ton of 2000 Lb.)

	Zinc Ores		Lead Ores	
	High	Average	High	Average
1908	$47.00	$43.20	$66.00	$54.66
1909	55.00	41.08	60.50	54.56
1910	52.00	40.42	58.00	51.98
1911	51.00	39.90	64.00	56.76
1912	67.00	53.33	68.00	56.60
1913	59.00	42.26	58.00	52.52
1914	54.00	40.46	54.50	46.55
1915	138.90	79.30	80.00	55.08
1916	131.70	84.72	104.84	84.07
1917	101.95	67.70	135.50	98.00
1918	78.70	51.33	106.00	88.98

a small mill has been erected, and at Alba one mill has resumed under new management. The three properties of the Athletic Mining and Smelting Co.—the Athletic, at Duenweg; the Bertha A, at Webb City; and the Mutual, at Oronogo—with the Circle mine, of the Connecticut Zinc Corporation, at Oronogo, produce the bulk of the blende obtained at these three points. All other southwest Missouri counties fell far behind their 1917 record, with the one exception of Barry County, which made a small shipment each of blende and calamine.

The increase in zinc production for Cherokee County, Kan., came from new sources, as the galena production decreased. The greater increase came from the Blue Mound section, near Treece, with a fair increase opposite Waco. Prospecting during 1917 and developments in 1918 offer promise of greater gains in 1919 from each

TABLE II. MONTHLY AVERAGE PRICES OF BLENDE, CALAMINE, AND LEAD IN 1918, IN THE JOPLIN DISTRICT
(Per Ton of 2000 Lb.)

	Blende	Calamine	All Zinc Ores	Lead
January	$56.01	$35.97	$55.14	$74.37
February	55.84	37.46	54.99	78.75
March	54.40	38.08	53.72	85.04
April	47.56	32.82	46.96	83.50
May	44.59	31.89	44.16	81.81
June	49.61	34.53	48.78	87.99
July	52.52	35.66	51.89	97.16
August	55.75	36.66	54.83	98.17
September	53.26	37.91	52.73	101.36
October	53.80	37.91	52.95	99.47
November	53.29	39.62	51.97	100.13
December	44.16	36.00	44.00	83.00
Year	$52.00	$37.14	$51.33	$88.98

of these areas. Prospecting between Blue Mound and Baxter Springs suggests the possibility of developments that will return a notable production.

In northern Ottawa County, Okla., it is estimated that if the zenith has not been attained it will be passed by mid-year of 1919. The blende shipments of 1918 increased over 100%, and those of lead showed nearly 100% increase. A visible stock of approximately 20,000 tons of blende is stored in bins in this area, with 50% to 60% of it sold. In eastern Ottawa County, a prospecting campaign has resulted in some developments in the vicinity of Peoria, close to the Missouri line.

Flotation practices made marked strides, in the field under review, during 1918, accomplishing astonishing results for those installing it as an experiment, and establishing it as a fixed and approved method for the concentration of fines. Installations were made in some instances to handle the fines passed over sludge tables, and the later installations have exclusive flotation treatment of fines.

Volunteering, the engineering corps, the draft, and Government employment at higher wages than paid in the mines, called many of the efficient workmen from this field. These causes, with the influenza epidemic, and inefficiency, aided in preventing the accumulation of a disastrous surplus ore stock in the district.

Zinc blende prices at the beginning of 1918 were on a basis of $70@50, falling to $65@50 at the end of February, to $60@40 the end of March, and to $55@37.50 at the end of April. The first of May brought a fixed basis for premium grades at $75, which was carried through the rest of the year. An allocating committee adjusted a division of the shipment among producers. By the end of June, a second rating of ore for Class B spelter was arranged by which a part of

TABLE III. SHIPMENTS OF BLENDE, CALAMINE, AND LEAD IN THE JOPLIN DISTRICT, WITH VALUES

	Blende, Lb.	Calamine, Lb.	Lead, Lb.	Values
Missouri				
Jasper County	174,580,220	9,755,710	36,396,960	$6,547,370
Newton County	22,435,510	27,023,930	535,520	1,108,130
Lawrence County	3,060,860	4,517,970	187,220	162,880
Greene County	524,010	83,300	.....	14,160
Christian County	231,040	165,510	.....	6,110
Howell County	.....	171,310	.....	1,800
Dade County	.....	115,880	.....	1,630
Barry County	34,270	59,390	.....	1,230
Totals	200,865,910	41,893,000	37,119,700	$7,843,310
Oklahoma				
Ottawa County	643,227,720	.....	101,025,910	21,467,400
Kansas				
Cherokee County	99,932,840	.....	10,899,150	3,187,000
Arkansas (a)	200,980	3,779,510	81,730	81,290
1918 District Total	944,227,450	45,672,510	149,126,490	$32,579,000
1917 District Total	884,326,450	75,564,480	144,392,770	41,126,610
Increase	79,901,000	.....	4,733,720	.....
Decrease	.....	29,891,970	.....	8,547,610

(a) Ores settled for by Joplin purchasing agencies. An estimate of Mr. Dunlap, of the U. S. Geological Survey, places the total Arkansas production at 5000 tons blende and calamine, and 200 tons of lead.

the production received practically a fixed price until the end of November of $60@55 basis. A third rating of ore entering into the production of Prime Western spelter lasted for three weeks in November, an agreed schedule being paid by several purchasing agencies. December closed with an open market for all grades of blende, with the price on a basis of $46@42.50. Calamine prices began on $38@31 basis, falling to $33@30 the middle of February, after which a $40@35 basis prevailed to the end of March. April opened with $35@30, closing at $30@25, which quotation extended to the third week of July, when a basis of $35@25 generally ruled. The next week it advanced to $37.50@30, ending August at $40@35, a price that continued, with a few exceptions, to the end of November, when it dropped to $38@30. Lead advanced from a basis of $83@80 to $88@86 the second week of March, then fell to $80 at the end of April, advancing steadily to $100 basis the third week of July. Occasional sales at a premium gave a basis equivalent of $103 at various times until the end of November, when the market dropped to an $80 basis.

*Statistician, Joplin, Missouri.

Iron and Steel

THE year 1918 will always remain a memorable one in the steel industry. The distinguishing feature was the contrast between the beginning and the end of the year, and the complete coöperation that prevailed in the face of increasing demands for steel is greatly to the credit of the various governmental boards and the heads of the industry. In May, the Director of Steel Supply announced that the entire United States steel production must be placed at the disposal of the country, and in June the industry voluntarily accepted Government supervision. This resulted in a system of priorities in production and delivery that was maintained in full until the signing of the armistice. After that date there were cancellations, and prices dropped, but the efforts of the industry to bring about a readjustment, a continuation of satisfactory labor conditions, and a stable basis throughout were untiring.

TABLE I. LAKE SUPERIOR IRON-ORE SHIPMENTS
(In Long Tons)

	1916	1917	1918
Escanaba	7,457,444	7,156,854	6,774,969
Marquette	3,858,092	3,207,145	3,457,054
Ashland	8,057,814	7,597,841	7,565,608
Two Harbors	10,735,853	9,990,901	8,723,472
Superior	12,787,046	13,978,741	14,068,341
Duluth	21,837,949	20,567,419	20,567,288
Totals by lake	64,734,198	62,498,901	61,156,732
Totals all rail (est.)	1,924,268	1,938,102	2,000,000
Total shipments	66,658,466	64,437,003	63,156,732

TABLE II. MONTHLY PRODUCTION OF COKE AND ANTHRACITE PIG IRON IN THE UNITED STATES, BEGINNING JAN. 1, 1914
(In Long Tons)

	1914	1915	1916	1917	1918
January	1,885,054	1,601,421	3,185,121	3,150,938	2,411,768
February	1,888,670	1,674,771	3,087,212	2,645,247	2,319,299
March	2,347,867	2,063,834	3,337,691	3,251,352	3,213,091
April	2,269,655	2,116,494	3,227,768	3,334,960	3,288,211
May	2,092,686	2,263,470	3,361,073	3,417,340	3,446,412
June	1,917,783	2,380,827	3,211,588	3,270,055	3,323,791
July	1,957,645	2,563,420	3,224,513	3,342,438	3,420,988
August	1,995,261	2,779,647	3,203,713	3,247,947	3,389,585
September	1,882,577	2,852,561	3,202,366	3,133,954	3,418,270
October	1,778,186	3,125,491	3,508,849	3,303,038	3,486,941
November	1,518,316	3,037,308	3,311,811	3,205,794	3,354,074
December	1,515,752	3,203,322	3,178,651	2,882,918	3,433,617
Totals (a)	23,049,752	29,662,566	39,039,356	38,185,981	38,506,047

(a) Totals do not include charcoal pig iron. Figures secured from *Iron Age*.

Lake shipments of iron ore from the Lake Superior districts for 1918 were 61,156,732 tons, a decrease of 1,342,169 tons from 1917, when 62,498,901 tons was shipped. Cuyuna Range shipments totaled 2,432,838 tons, an increase of 9954 tons over those of 1917. It is estimated that approximately 700,000 tons of manganiferous iron ore was shipped in 1918 from the Cuyuna. Rail shipments during 1918 increased over those of 1917 and probably exceeded 2,000,000 tons. The Lake shipping season was practically completed the latter part of November. Through the excellent cooperation of the various committees directing the Lake trade, transportation and distribution of ore were adequately arranged and ample supplies furnished to the furnaces.

The increase of 37c. per ton in freights, and the three voluntary wage increases, which originated in Eastern steel mills and were continued to the iron mines, were forceful arguments for the increases in iron-ore prices. At the beginning of the season these remained on the same basis as in 1917. On July 21, 1918, a 45c. increase was granted, and, effective Oct. 1, a further increase of 25c. per ton was allowed.

TABLE III. PIG-IRON PRODUCTION (a) FOR 15 YEARS
(In Long Tons)

1904	16,497,003	1909	25,795,471	1914	23,332,244
1905	22,992,380	1910	27,303,567	1915	29,916,213
1906	25,307,391	1911	23,649,547	1916	39,434,797
1907	25,781,381	1912	29,726,937	1917	38,621,216
1908	15,936,918	1913	30,966,152	1918 (b)	38,820,000

(a) American Iron and Steel Institute.
(b) Estimated.

TABLE IV. PIG-IRON PRODUCTION BY GRADES

Grades	1917 Long Tons	1917 Per Cent.	1918 (a) Long Tons	1918 (a) Per Cent.
Basic	17,671,662	45.8	18,361,860	47.3
Bessemer	13,714,732	35.5	12,810,600	33.0
Foundry	5,328,258	13.8	5,357,160	13.8
Malleable	1,015,579	2.6	1,281,060	3.3
Forge	345,707	0.9	427,020	1.1
Spiegeleisen	171,685	0.5	194,100	0.5
Ferromanganese	281,425	0.7	310,560	0.8
All other	92,168	0.2	77,640	0.2
Totals	38,621,216	100.0	38,820,000	100.0

(a) Estimated.

Final prices were: Old Range bessemer, $6.65; Mesabi Range bessemer, $6.40; Old Range non-bessemer, $5.90, and Mesabi Range non-bessemer, $5.75 per ton.

Pig-iron production in 1918 was about 38,820,000 tons of all grades, as compared with 38,621,216 tons in 1917. In the early part of the year, production of pig iron fell below that of previous years, but reacted strongly with advancing demands. Production of steel ingots in 1918 showed a decrease from that of 1917, when it was 43,700,000 tons. Shell steel was the largest in demand, and approximately 5,000,000 tons was produced.

Pittsburgh Iron and Steel Markets

BY B. E. V. LUTY*

AS THE Great War lasted through more than 10 months of 1918, the course of the iron and steel industry in the year must be viewed chiefly from a war standpoint. Except for the unfortunate curtailment in output in the first two months of the year, caused by traffic conditions, the tonnage output was fairly satisfactory. It was not by any means equal to capacity, but there were various barriers to full production, and on the whole the showing was a gratifying one. Owing to the lessened pressure for material after the signing of the armistice, there was a slight falling off in production. Altogether, the 1918 output of steel ingots was about 42,000,000 gross tons, comparing with about 43,700,000 tons in 1917 and 41,400,000 tons in 1916.

There was more or less labor shortage in the iron and steel industry throughout the war, but the curtail-

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ment in output on this account was not great in itself. The labor shortage fell largely upon construction work, which the mills had to forego. As to performance, common labor was more or less indifferent, and hardly rendered as good service for the high wages paid as it had rendered in former times for wage rates half as high. Skilled and partly skilled labor, however, performed their work very well.

One obstacle to the fullest production of steel ingots was the shortage of scrap of good quality, which was simply a result of the character of the industrial operations being carried on. As the railroads were short of cars, locomotives, and new rails, as well as of labor to lay rails, there was little scrapping of material, and thus the railroads did not furnish their usual quota of old material. There was hardly any new construction except for war purposes; hence little wrecking of bridges and buildings. Again, much steel was shipped out of the country in unfinished form, and the scrap resulting from converting such steel into manufactured goods was produced abroad.

At times there was a shortage of steel-making pig iron, and this was notably the case in January and February, when the inability of the railroads to move coal and coke resulted in light operations at blast furnaces. Thus it is not surprising that only about 42,000,000 tons of ingots was produced in 1918, although the capacity, under normal working conditions, is undoubtedly more than 47,000,000 tons. Production of ingots in 1913 was 30,300,000 tons, and capacity at the close of that year, or at the beginning of the war, was about 34,000,000 tons, so that there has been an increase of about 40%. This, however, is not particularly excessive, considering the previous growth of the steel industry. The history of that industry, however, shows that it is to the domestic market, rather than to foreign markets, that the steel makers must turn for demand to engage this capacity.

Government price regulation of the iron and steel industry worked fairly smoothly. Arguments were made from time to time that higher prices should be allowed, but much of the talk indulged in was doubtless for the purpose of forestalling reductions which the authorities might have had in mind. The great majority of producers made large profits, subject to heavy taxes, though a few small producers had only a scant margin, and were less subject to taxation.

The important finished steel products were unchanged as to price during the period of Government control, though two changes were made in pig iron in 1918, one being a reduction and the other an advance table.

The year opened with pig iron at a basing price of $33, f.o.b. furnace, bessemer being 10% higher, or $36.30. Foundry iron at base price was such as contained 1.75 to 2.25% silicon, and the No. 2X made by Eastern furnaces, running 2.25 to 2.75%, was 50c. in advance, or $33.50. On Apr. 1, basic iron was reduced $1, to $32, bessemer being still 10% above basic, or $35.20. On Oct. 1, the basic price of pig iron was increased $1, but this did not apply to bessemer. The advance on foundry iron with silicon 2.25 to 2.75% was increased from 50c. to $1.25. Eastern Pennsylvania furnaces were given a Pittsburgh basing, and Virginia and Tennessee a Birmingham basing, whereby the furnaces mentioned experienced a separate and additional advance. Government prices continued to the end of the year 1918, with no definite prospect of a decline.

The last quarterly meeting between the War Industries Board and the general committee of the American Iron and Steel Institute was scheduled for Dec. 11. The committee attended the meeting prepared to submit a schedule of price reductions to rule for the first quarter of the new year, but, not much to the surprise of the committee, the War Industries Board refused to have the statement even read into the minutes, explaining that it was through price fixing. The statement was thereupon given to the press. The steel producers immediately began quoting the suggested reduced prices, but the pig-iron producers did not recognize the $3 reduction suggested for pig iron. The accompanying table shows average prices in 1917, Government prices and the reduced prices effective after the meeting of Dec. 11 for 1918. Billets are per gross ton. Beams, plates, bars, and black sheets are per 100 lb. Pipe is represented by a basing discount from list, and nails are per keg, base.

PRICES OF STEEL PRODUCTS

	1917	1918	
		Government	Reduced
Billets, per gross ton	$71.16	$47.50	$43.50
Beams, per 100 lb.	3.66	3.00	2.80
Plates, per 100 lb.	5.21	3.25	3.00
Bars, per 100 lb.	3.49	2.90	2.70
Black sheets, 28 gage, per 100 lb.	6.29	5.00	4.70
Pipe, discount from list	52½%	51%	54%
Wire nails, per keg	$3.56	$3.50	$3.50

During Government control ferromanganese stood at $250, delivered, for 70%, as the result of an informal understanding. At the close of 1918 a new market price had not been definitely established.

At the beginning of 1918, the War Industries Board was exercising only a limited amount of control over the distribution of iron and steel, its regulations pertaining chiefly to prices. By reason of growing needs for steel, and the reduced rate at which steel was made early in the year, it became necessary that the steel industry should recognize more fully the war-time requirements, and the Director of Steel Supply had to make the industry fully acquainted with the fact. At a meeting held on Apr. 26, the iron and steel producers took a "100% efficiency pledge," promising their entire efforts would be directed toward helping to win the war.

In June the scheme of distribution, which had previously covered only a certain number of priorities, was greatly extended, and in July "automatic priority" was provided for many cases in which previously it had been necessary for the War Industries Board to issue individual priorities. The sequence of importance was as follows: Class AA priorities, Class A priorities, Class B priorities, Class C, or preference steel, and Class B, or permit steel. No steel could be manufactured or shipped against a given class of orders until provision had been made that all steel of a higher order would be made and shipped within the time required by the buyer. The preference list was a "list of purposes entitled to preference treatment." After priorities and preference wants were fully met, producers could make and ship Class D steel, upon written permission, for purposes not recognized as essential.

An important thing that this distribution system showed was that steel is the backbone of industry, for when nearly all industries were summoned to help win the war they required more steel than could be made.

There was a shortage, yet there were few industries that were denied steel.

Larger wage advances occurred in 1918 than in either of the two preceding years. From the general wage advance of Feb. 1, 1913, to the beginning of 1916 there was no general change in wage rates in the iron and steel industry. Wage advances during the war period occurred as follows: 1916, Feb. 1, May 1, Dec. 15; 1917, May 1, Oct. 1; 1918, Apr. 15, Aug. 1, Oct. 1. All these advances averaged about 10% each, except that the advance of Apr. 15, 1918, was about 15%, and the advance of Oct. 1, 1918, was chiefly the establishment of the basic eight-hour day system of payment, providing 14 hours' pay for 12 hours' work and 11 hours' pay for 10 hours' work, with some advances to eight-hour men to equalize. The standard hourly rate in 1915 was about 19c. for common labor, this increasing to about 42c., Aug. 1, 1918, though after the establishment of the eight-hour basic day 12-hour men received an actual average of 49c. per hour, or two and one-half times the rate in 1915.

Though such wages appeared excessive, no way to effect a reduction presented itself at the close of the war. The iron and steel industry sought to secure more efficient performance as one means of reducing its extremely high wage cost per ton. As to its business prospects, the industry recognized that the cost of putting steel into employment was extremely high, through high wage rates and indifferent performance of labor in the building and other trades consuming steel, and that this would have a great influence upon investors in permanent construction work.

Iron Mining in the United States

THE extraordinary demand for iron ore in 1918 was met by a sustained and successful effort on the part of the mine operators to keep pace with the requirements. Though the total shipments from the Lake Superior districts were less than in 1917, they were sufficient to provide the furnaces with the necessary stocks to carry them over until next season. At practically all of the iron-producing districts, operations were impeded by insufficiency or inefficiency of labor; the draft called a number of the men, the influenza epidemic had a further serious effect on the situation, and in some districts there was a tendency for some of the men to seek other work. Toward the close of the shipping season, and the accompanying slowing down of outside operations, the labor situation became easier.

There were no strikes or labor troubles during the year in the iron-mining industry. In the Lake Superior districts, wages were increased three times, all of the operators following the lead set by the United States Steel Corporation. In spite of the fact that the price of iron ore was raised twice during 1918, the independent ore producers operated under a real hardship, as the increase in ore prices was only sufficient to cover the raise in freight rates, and operative costs continued to rise. Common surface labor received $4.84 per day, and average contract miners were paid 83c. per hour, so that it was little wonder that even large underground operations piled up costs of $4.40 to $4.60 per ton of ore, placed in cars at the mine. In Tennessee, wages have increased 150% in the last three years; in the New York iron mines they were practically doubled during 1918.

The more extensive utilization of labor-saving devices was not so marked in 1918 as had been expected. However, the various types of improved machinery and apparatus which were adopted in 1917 on the Mesabi Range were used extensively in 1918. On the Gogebic Range, the Halby, Hoar, and Middlemiss shoveling machines were installed in several of the mines, and in the New York magnetic mines electric shovels were used underground to compensate for the shortage in men required for mucking operations.

In the Lake Superior districts, with the larger companies, the high taxes on profits resulted in unusual activity in exploring and the taking of bigger chances. New development and new equipment appealed to few, as the depreciation allowed by present tax laws meant that one would not be allowed to charge off the real shrinkage in the value of the plant before paying the larger part of the income in taxes. The changes in railroad transportation were burdensome to the mine operator, and the ruling which requires the industry to pay for all railroad spurs and tracks and for all service other than actual hauling of the ore was a great drawback to new development. Though it compelled those industries that could do so to establish themselves close to the railroads, the mines are "where they are," and even the old rates (before the present double rates) for shipping ore to the head of the lakes were excused on the ground of the extra service given in the way of building spurs and sidings, switches at stockpiles, and storage in cars and at the docks. During 1918 all of these were charged for, in addition to the doubling of the haulage rates, and these increases constituted a permanent expense on the cost sheet.

New Shafts Sunk on Mesabi Range

On the Mesabi Range of Minnesota, both open-pit and underground properties were active, although there were few new shippers. Among new shafts sunk were the Majorca, at Calumet; the South Agnew, at Hibbing; the Johnson, at Virginia; the Wistar, at McKinley; and the Pilot mine, at Mountain Iron. At Kewatin, on the western Mesabi, Butler Bros. completed stripping the Bennett mine, and ore was loaded from the pit on contract by the Guthrie company. The mine is operated by Pickands, Mather & Co., which company conducted underground operations. The Mississippi was a new shipper in 1918, having been taken over by the Interstate Iron Co. The International Harvester Co. sunk a shaft at the Sargeant mine and completed buildings. The property is to be operated as an underground and open-pit mine, and stripping is being done by the Winston-Dear Co. A number of workmen's houses were built at various points by the Oliver, Cleveland

Cliffs, Pickands Mather, and Shenango companies. Building of washing plants on the western Mesabi was brisk, but no new treatment methods were brought out in 1918. The first shipment of low-phosphorus sinter produced from eastern Mesabi magnetic ores was made. The Wade mine, at Kinney, formerly the Helmer, was acquired by the Cleveland Cliffs Iron Co. Changes in ownership during 1918 were mostly in the cleaning up and leasing of the Great Northern ore lands, and lands that were associated with the Great Western Mining Co. Few ore lands are now obtainable on the Mesabi Range.

Manganiferous Iron-Ore Mines of Cuyuna Developed for War Market

During 1918 an active season prevailed at the mines on the Cuyuna Range, although the close of the year shows an unsettled condition among operators of the small manganiferous iron-ore properties. These mines were developed for a strictly war market, and the releasing of tonnage for the unrestricted importation of foreign manganese ore and ferromanganese leaves them in a precarious position. Shaft sinking was carried on at the Northland, Ida Mae, Preston, Merritt, Adbar, Clark, Joan No. 3, Hopkins, Cuyuna-Mille Lacs, Cuyuna-Duluth, Martin, Huntington, Arko, and Bonney Belle mines. The Cuyuna-Duluth, Croft, Thompson, Preston, and Gloria mines, all underground properties, closed early in December. The Oneida Mines Co. built and operated the only manganiferous iron ore washing plant on the Cuyuna Range, at the Cuyuna-Sultana mine. The Omaha Iron Co. erected a drying plant at the Wilcox mine, which was completed in July. There was considerable new construction in surface plants and buildings, most of which was carried on at the new properties.

Two New Mines Opened on Marquette Range

On the Marquette Range, in Michigan, several diamond drills were operated throughout 1918 by the Cleveland Cliffs Iron Co. in prospecting for other orebodies to take the place of those which are being exhausted. Some exploration was done by the Florence Iron Co. at the Kloman mine, at Republic. New mines opened were the Maitland, at Palmer, and the Barnes-Hecker, at Ishpeming. The Maitland and the Francis and Mackinaw mines, in the Gwinn district, were new producers in 1918. The Princeton mine, at Princeton, was reopened. Producers in 1918 were: American, Angeline, Athens, Breitung-Hematite, Cambria, Cliffs Shaft, Empire, Francis, Gwinn, Holmes, Isabella, Lake, Maas, Mackinaw-Gardner, Maitland, Mary Charlotte, Morris-Lloyd, Negaunee, Princeton, Republic, Salisbury, Section 16, and South Jackson mines.

New Orebodies Opened on Gogebic Range

Considerable drilling was done during 1918 on the Gogebic Range by the Jones & Laughlin Ore Co., and the Republic Iron and Steel Co. The latter has taken over the old Plummer mine, near Iron Belt, Wis., and is unwatering the shaft. The Newport Mining Co. is exploring the old Atlantic mine, at Iron Belt. The Morgan mine, near Wakefield, is being opened by the Thomas Furnace Co., which is sinking a shaft. The Townsite Mining Co., incorporated by A. B. Coates, G. P. Tweed, and L. C. Brewer, of Duluth, and G. H. Rupp, of Ironwood, took over the old Norrie property, which was surrendered by the Oliver Iron Mining Co. in 1916. The property produced about 85,000 tons of bessemer ore in 1918. The Plymouth mine, near Wakefield, was sold by Coates and Tweed to Pickands-Mather & Co., and the Midvale Steel Company. The East Norrie, Montreal, Townsite, Castile, and the Ironton mines have opened up new orebodies, of which the East Norrie body is showing considerable extent. These orebodies are generally in the hanging, and north of the foot-wall side of the iron formation, which was formerly considered to be the only productive ore area. Producers in 1918 were the Montreal, Ottawa, Eureka, Asteroid, Castile, Cary, Windsor, Brotherton, Sunday Lake, Plymouth, Ashland, Townsite, Yale, Newport, Anvil, Palms, Norrie-Aurora, Pabst, Vaughan, Davis, Puritan, Tilden, Ironton, Colby, and Wakefield mines.

First Vertical Shaft Being Sunk in Alabama Iron District

In the Birmingham, Ala., district, sinking was begun during 1918 on the first vertical shaft for mining iron ore, and this work is being continued on Red Mountain. In August, a decision, made applicable to the entire district, was reached by the War Labor Board whereby wage increases were granted and other adjustments made. The award establishes a wage schedule by which no mine worker shall receive less than $3.99 for a 10-hour day. The Tennessee Coal, Iron and Railway Co., Republic Iron and Steel Co., Sloss-Sheffield Steel and Iron Co., Woodward Iron Co., and the Alabama Iron and Fuel Co. were active in 1918.

In the New York magnetite district, no exploratory work was done, as all available labor was engaged in increasing the output from developed workings. The Chateaugay Ore and Iron Co., at Lyon Mountain, has partly completed the company's new magnetic concentrating mill, which is to have a capacity of 100 tons per hour. During 1918 producers were Witherbee, Sherman & Co., at Mineville; Chateaugay Ore and Iron Co., at Lyon Mountain; Cheever Iron Ore Co., and Port Henry Iron Ore Co., at Port Henry, New York.

Operations in Tennessee

In Tennessee, the Standard Iron Co., of Nashville, acquired the Aetna property at Aetna during 1918 and has been operating by open cut, using steam shovels. Log washers and jigs are employed in concentrating the ore. The Lafollette Coal and Iron Co., Lafollette, is electrifying its mine, and the power plant is using waste gas from the blast furnace. The Bon Air Coal and Iron Corporation, of Allens Creek, is preparing to open a mine at Nunelly. J. J. Grey, Jr., of Rockdale, has been developing a mine near Iron City which is expected to operate early in 1919.

Overhand Stoping in New Jersey Iron District

Of a large number of old mines in the New Jersey iron district only two operated during 1918, the Mount Hope mine, of the Empire Steel and Iron Co., and the Richard mine, of the Thomas Iron Co., both situated near Dover. At the Richard mine, a three-

compartment shaft has been sunk to a depth of 1100 ft. and a new steel headframe, hoisting plant, and a magnetic cobbing mill, with jaw and disk crushers, have been installed. New mine development which took place during 1918 consisted of dewatering and opening up of the old Hibernia mine by the Wharton Steel Co., of which J. Leonard Replogle is the head and principal owner. This company also opened up the Scrub Oak mine and developed a large tonnage of bessemer ore during the year. The property has been equipped with a 2500-ton magnetic concentration mill, which is in operation. Mining methods in this district consist of overhand stoping, with haulage levels placed from 100 ft. to 250 ft. apart. Electric haulage is used, and stope chutes are placed at about 40-ft. centers. The orebodies dip at about 60°, and no trouble is experienced in drawing stopes, even when the stope height is 250 ft. along the dip of the vein. The average breaking per drill shift, using one-man stoping drills, is about 25 tons. The only new property prospected during 1918 is the old Dickerson mine, which has been dewatered by the Black Rock Iron Mining Co., of Dover. Producers in 1918 were the Mount Hope, Richard and Scrub Oak mines.

Western Iron-Ore Mining

The lease on the Snowflake, Jim, Fair, and Cupola mines, at Fiero, N. M., which was held by the Colorado Fuel and Iron Co., expired Sept. 1, 1917, at which time the management of the properties was assumed by the Hanover Bessemer Iron and Copper Co., Fiero, N. M. This company shipped the entire output of these properties during 1918 to the Colorado Fuel and Iron Co.'s steel works at Pueblo, Colorado.

The Noble Electric Steel Co. operated a mine in the Pitt River district, California, in 1918. A prospecting tunnel which cuts the orebody 160 ft. below the present working level was completed. No crosscutting or stoping was done on this level, but work preparatory to mining by the gloryhole method was carried on.

Antimony in 1918

By K. C. LI*

ANTIMONY in 1918 presented a spectacle of less interest than in any year since the beginning of the world war. During the early days of the war there was a phenomenal advance in prices, which culminated at 45c. per lb. in the winter of 1915-16. This was followed by the sensational decline of 1916; but, despite the fact that consumption of the metal continued on a large scale for munitions of war, at no time in 1918 was there anything resembling a flutter of excitement in the market. Several causes contributed to this constant appearance of dullness, the chief being the abundance of supply, and the keen competition among holders to secure a share of the business. It is fairly safe to say that little profits have been netted, either by producers or middlemen.

AVERAGE MONTHLY PRICES OF ANTIMONY (a)

(In Cents per Pound)

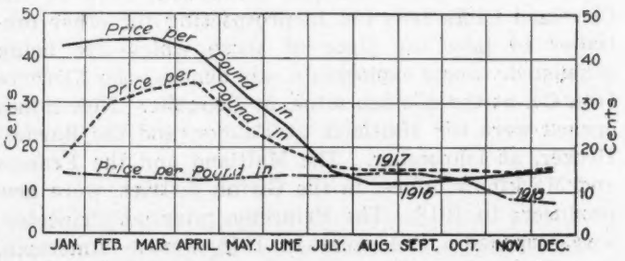
	1915 Ordinaries	1916 Ordinaries	1917 Ordinaries	1918 Ordinaries
January	15.85	42.45	17.29	14.281
February	18.21	44.31	29.80	13.823
March	22.13	44.75	32.89	13.091
April	24.88	42.06	34.04	12.536
May	35.30	31.60	25.20	12.846
June	37.69	20.05	19.51	13.055
July	38.13	14.70	15.83	13.197
August	33.00	11.53	15.06	14.000
September	28.63	11.81	14.94	14.145
October	31.45	12.70	14.75	13.319
November	38.88	13.84	13.91	8.771
December	39.25	14.59	15.06	7.915
Year	30.28	25.37	20.69	12.581

(a) *Engineering and Mining Journal* quotations.

As far as an outsider can estimate, the United States Government consumption of antimony was at the rate of at least 500 long tons per month throughout the entire year, but the requisitioning was carried out in such a judicious manner, and importers coöperated with so much willingness, that the prices were disturbed but little. In fact, competition to obtain Government business was so great, that, despite the steady demand, the tendency of prices was downward rather than upward. Furthermore, since the scare of 1916, speculation in antimony metal has been conducted in a cautious way, and jobbers have been wary of getting a large stock on hand.

Canadian and Russian Demand

The Canadian government was also a heavy purchaser during the year, although not to such a large extent as formerly. It is known that during 1916 and 1917, from 2500 to 3000 tons of antimony was used each year for the manufacture of munitions for England and Russia.



ANTIMONY PRICES 1916, 1917, 1918

A large proportion of the metal, although bought through concerns in the United States, was imported direct from the Orient to Canada. With Russia out of the war, the quantity required during 1918 was naturally less, and it is probable that the amount did not exceed 1500 tons.

Antimony Importations

The apparently abundant supply of metal throughout the year seems to indicate that importations from China and Japan continued on almost the same scale as formerly, in spite of the fact that prices were seldom above 14c. per lb. The importations for the nine months

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ended Sept. 30 bear out the statement. According to Custom House figures these were as follows:

Antimony in ore, 2,479,673 lb., valued at $155,307; antimony matte and regulus, 20,788,681 lb., valued at $2,018,638.

It would appear that producers, especially those in the Far East, have kept up their output, always in the hope that prices would again advance to something near the extraordinary level of the winter of 1915-16. There can be no other explanation of the plentiful supply, because the margin of profit during 1918 was certainly not such as to warrant overproduction. After the fabulous prices obtained at the beginning of the war, there is nothing surprising in the persistence of this hope in the Oriental mind. The high rate of exchange which existed in China throughout 1918, coupled with increased cost of materials used in smelting, raised the expense of production more than 100%, and it is questionable whether the present cost is likely to decrease for some time. In addition to this, the cost of transportation and warehousing and other charges have greatly increased, and it would therefore appear that, when the disturbances caused by the ending of the war have subsided, the tendency of prices would be upward from the present level.

Position of China Maintained

It is interesting to note that from available reports regarding exports of antimony to the Unied States, either direct or via Japan, China has maintained her predominant position as a producer. Antimony was one of the metals discussed by the United States Tariff Commission with a view to ascertaining whether it would be wise to increase the rate of duty. It is not known what the ultimate policy in respect to antimony will be, but, with all due deference to the opinions of domestic producers, it seems to me that, with the passing of the war demand, there is little to be gained by increasing the present rate of duty on the metal. The domestic uses of antimony have not been developed to any great extent, and the prosperity of any industry cannot safely depend upon a state of war. An abundant supply can now be obtained at relatively low cost, and the need of the moment is for research to discover new uses and applications for this hitherto comparatively unimportant metal.

Antimony Prices

As already indicated, prices throughout 1918, until the signing of the armistice, ruled very steady. Such fluctuations as took place did not amount to more than one or two cents per pound. At the beginning of the year the price was a little over 14c. per lb., with a steady but slow decline as the year advanced. During May, a price just over 12c. per lb. was reached, and then began a slow advance, until, in September, 14c. was again realized. From that time on, prices declined steadily, and, with the signing of the armistice, there was a drop to about 8c. It may be that the price now obtaining will continue for some time, because it is probable that the ending of the war, which, after all, came rather suddenly, found importers and jobbers with considerable stocks. This, of course, is mere surmise on my part, and I have explained in another part of this article that there are other causes tending to force the price upward.

In any case, the future of the world and civilization is something immeasureably greater than the future of any particular metal or industry, and we are all happy that the new year will see the resumption of business on the safe and sane basis of a world peace.

The Tin Market in 1918

By J. H. Lang*

A review of tin after the usual fashion is not possible for 1918, owing to the lack of reliable statistics. No information as to shipments has been given out, and no estimate of the visible supply is possible. The Metal Exchange publishes deliveries here and in London, and imports for 1918, together with comparisons for 1917. According to the Government, imports during 1917 were 64,428 gross tons, instead of 54,867 tons, as reported by the exchange. Official figures for 1918 are available only to the end of October, to which date they show 56,064 tons, against 51,603 tons according to the Metal Exchange.

Prices for Straits tin in London and parity of same in U. S. Currency were as given in the accompanying table:

LONDON MARKET FOR SPOT STRAITS TIN

	London—Pounds Sterling per Long Ton	U. S. Currency Equivalent in Cents per Lb.
Open January 2	270 0 0	57.50
High August 2	399 0 0	84.75
Low December 19	236 0 0	50.15
Close December 31	236 0 0	50.15

For the greater part of 1918 there was no recorded American market. Straits in New York opened at 75c. per lb., and within a week went to 85c. Thereafter published quotations were suspended. During the month of January spot sales were reported as high as $1 per lb. In the early spring both Straits and Banca practically disappeared from the market. This was due more to numerous restrictions and to fear of shortage rather than to actual dearth of supplies. Later the situation was aggravated by an embargo on exports of Banca tin from Batavia. Transactions represented chiefly small lots, and price was a matter of private negotiation. Chinese tin was sold at $1 per lb.; Straits was quoted as high as $1.25, with authenticated sales at $1.10. All the time there was furious bidding by American buyers in the Straits, forcing the price there to over £400, or more than 90c. per lb. c.i.f. U. S. ports, a condition which the authorities seemed powerless to remedy, or to prevent the serious overbuying which occurred. The turning point came about the middle of 1918, and an easier tendency was noted from then on. Efforts were made to stabilize Straits prices, and to those who could procure export licenses from the British authorities Straits tin became available at much lower prices than Banca or Chinese.

Settlement of the shipping question with Holland, rumors of price fixing and large arrivals unsettled the market, and prices fell away rapidly on small business. Banca and Chinese sold early in August at 92@93c., and by the end of August at 86@84c., respectively. The announcement of the Inter-Allied control was made in September. According to this plan, buying in primary markets was confined to official agencies, and no

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tin could come to this country except that consigned to the U. S. Steel Products Co. Importers were eliminated. Thereafter the only tin in the open market was scattered spot lots and parcels already afloat or contracted for, and these could be sold only to buyers holding purchase licenses from the War Industries Board.

Allocations to the United States out of the Inter-Allied purchases are stated to be about 10,000 tons. The approximate cost is given at 72½c. f.o.b. Eastern points, and 71½c. f.o.b. Pacific Coast, at which price consumers will be compelled to take the metal.

It is understood that purchases for Inter-Allied account have ceased, and that no further allocations will be made. Also that no purchases by the U. S. Steel Products Co., or any other importer or consumer, with the exception of ore purchases by domestic smelters, will be allowed until further notice. These regulations place the smelters in an advantageous position to the extent that they are able to buy in open markets and sell on the closed American market, thus benefiting by the difference, which at the moment is about 20c. per lb. Markets of all other countries are now free and open except for restrictions necessary to maintain control here. Domestic production in 1918 was about 10,000 tons.

The length of time that it will take to absorb the U. S. Steel Products Co's. stock will be affected by a variety of considerations; by the state of business prevailing; by the amount of stocks in consumers' hands; by the quantity of tin turned out by domestic smelters, and by other conditions of a less specific nature. There are not lacking those who claim that in the disorganization of the country's industries attending transition from war to peace, consumption will be seriously curtailed, and possibly will not exceed 3500 tons per month. Against this will be first applied the unusually large stocks in consumers' hands, which it is estimated can be drawn on to the extent of 1500 tons per month for six months before return to normal. Then, the output of local smelters, which in 1919 should average 1500 tons per month, will have to be taken care of. Apparently it will be the second half of 1919 before the 10,000 tons in the hands of the U. S. Steel Products Co. is disposed of.

Information as to when and how America will again be allowed to deal in the world's markets will be announced later. Meanwhile, what these markets will do in the absence of the buyer who formerly took 60% of the total production is an interesting speculation. The English, Dutch, and Chinese are all heavily long of tin. Low prices are likely to prevail abroad, to the great detriment of American export trade in all articles containing tin. In fact, efforts are already being made to import such articles.

Bad as the situation now is, it will inevitably grow worse, and the trade is nonplussed as to why it should be thus handicapped and why the consumers of its products should be thus singled out and specially taxed. Opponents of the Government plan contend that the

NEW YORK METAL EXCHANGE TIN STATISTICS

	Arrivals U. S. Long Tons		Deliveries U. S. Long Tons		Deliveries London Long Tons	
	1917	1918	1917	1918	1917	1918
January	6,288	4,912	7,177	4,642	1,215	1,579
February	4,335	2,828	3,930	3,398	1,117	1,595
March	5,139	5,088	4,804	5,151	1,424	1,782
April	2,725	4,975	4,380	5,045	1,634	1,022
May	8,444	4,355	5,749	4,056	1,801	1,138
June	4,328	6,514	6,398	6,782	1,350	1,034
July	4,196	7,339	4,806	7,169	1,118	1,440
August	3,675	6,403	3,305	5,953	932	735
September	5,707	5,014	5,402	5,454	1,584	917
October	3,929	4,175	4,669	4,260	1,523	1,239
November	2,513	2,369	2,578	2,379	1,750	994
December	3,588	4,055	4,683	4,050	1,696 (a)	1,225
Totals	54,867	58,027	57,881	58,339	17,144	14,700

(a) Average estimated.

Inter-Allied stock was bought as a war measure and should be liquidated and the loss absorbed by the Government as a legitimate war expense. Eventually this will probably have to be done; otherwise criticism, now universal, if latent, is likely to flare out into open revolt.

Are American consumers going to be made to pay more for tin than the Germans? Both the wisdom and the necessity of the Government's action are matters of grave doubt, especially as, at the time it was taken, heavy stocks, large arrivals, and constantly falling prices all indicated that the crisis was passed. No other country has found it necessary to put into effect such drastic regulations, with such lasting and disastrous consequences, and the sooner they are abolished the better.

Labor and Mining in 1918

By F. F. SHARPLESS

IN TAKING a retrospective view of the mining industry during 1918, one is impressed more with what has been accomplished through man-power than through the accomplishments of horse-power. Called upon to produce greater quantities of the base-metal ores than ever before, the mines not only fulfilled all requirements, but in several instances exceeded them. This was brought about, not through any revolutionary methods in mining or milling, but through the personal efforts of prospectors, operators, and miners, using to the best advantage their skill and such appliances as were available, which in many instances were woefully inadequate or almost non-procurable at any price.

This extraordinary effort and increased production, accomplished in spite of decrease in the number of skilled miners available, was induced partly through high prices offered for the product, and partly through patriotism, which secured accomplishments regardless of cost or extent of effort. Whether it is one of the results of the war or is due to the gradual awakening of intelligence, there has come a realization of the fact that man-power is, in many instances, the most important element in production, and that through the proper education, development, and treatment of man his power factor may be raised.

J. Parke Channing presented a very thoughtful paper on man-power at the March meeting of the American Institute of Mining Engineers in Boston, wherein he dwelt upon the necessity of making our man-power more efficient. He directed attention to recent conditions in

England, where the laboring class, growing in ability to demand recognition, has acquired decidedly socialistic tendencies, suggesting that the same program is in store for the United States unless the employer realizes the justice of some of labor's demands and forestalls its ultra-socialistic ideas by improving working conditions. He recommends that our engineering colleges devote some time to human engineering, that their graduates, the future managers, may be better prepared to establish proper social and living conditions, at the same time improving efficiency; that these colleges and present managers study the subject of trades unions, not in order to destroy them but so that it may be possible to use them to the best advantage for the employer and employee. And not the least task is that of Americanizing the heterogeneous mass of humanity that goes to make up the personnel of a mining plant.

Throughout the mining districts of the West, more particularly at some of the larger plants, the work of studying and improving the man-power made notable progress during 1918, and constitutes perhaps the chief advance in the art of mining during the period under review.

Education of Workers

The education of mature men is not an easy task, and little can be accomplished in the lecture room or with textbooks. Education of the men referred to will be accomplished through the gradual improvement of conditions surrounding their place of employment, and the gradual realization on their part that these conditions render them more happy and contented than they were formerly. They will, under improved conditions, physical and other, have less desire to move; they will become a part of the mine and the community; they will become more interested in their work, and will give more thought to breaking an extra foot of ground than to quitting on the hour. One of the most difficult tasks that has been undertaken and is being solved is that of the Americanization of the large foreign population of the mining camps. Until foreigners have some conception of the American point of view, the manager's efforts may yield small return or be entirely unavailing.

When the manager has to deal only with Americans, the task is much simplified. The improvement of living conditions, or, if the mine has promise of long life, the improvement of housing conditions and the development of community interests, are immediately appreciated. If it is made easy for a miner to own his own home, and if that home has modern conveniences—if good schools are available and some suitable recreation is close at hand—a feeling of contentment is rapidly developed that is soon reflected in the turnover and in the tons mined per man.

The work of the Bunker Hill & Sullivan Company is typical of what is being done at several long-life mining properties. The acquisition of land for house and garden is made easy; liberal advances are made by the Bunker Hill & Sullivan company for building purposes, and every encouragement is given for men to own their homes. The schools are excellent, and the company has subscribed liberally toward furnishing intelligent recreation.

Charles Mitke, in the *Journal* of Jan. 26, 1918, explains in detail how the Phelps Dodge Corporation is endeavoring to solve the efficiency problem. The methods of education suggested by Mr. Mitke have been of such decided advantage to both employer and employee that they may well be taken as a model upon which to plan similar work at other mining plants. Lectures and discussions as to methods of mining and means of improving operations were first held for the benefit of foremen, bosses, and heads of departments. Attendance was not compulsory, but there were few absentees after the first or second discussion. Methods of putting in rounds, raising, timbering and other details were talked over, and, after trials, many of the suggestions have developed into standard practice. So successful were these conferences that they were widened to include miners, with the result that here, also, a better spirit of coöperation exists, and there is little complaint in a change of method after the miner has been carefully shown the advantage of a new method and what it is hoped to accomplish by its practice.

In an attempt to reduce the labor turnover and its accompanying inefficiency, the Phelps Dodge Corporation, the Calumet & Arizona Mining Co., and the Shattuck Arizona Copper Co., operating in the Warren district of Arizona, announced in January, 1918, that every man who has been in their service continuously underground for a year would receive a $100 bonus, with $50 for six months' service. Surface workers were given $60 and $30, respectively. The bonus was not given as a reward for staying with the company for one year, but rather as a recognition of the skill that might be acquired in that length of time. At this time the Copper Queen plant of the Phelps Dodge Corporation paid to its employees for the preceding year a bonus of $181,120, in which two-thirds of its men participated. It is not claimed that this represents the ideal method of payment for increased effiicency, which should be based on individual effort and attainment, but would contain so many complex facts that it would be impracticable for a large organization of slightly skilled laborers.

To facilitate coöperation and increase efficiency, the Oliver Iron Mining Co., in the Lake Superior district, has adopted a "mutuality plan." To carry out the purposes of this plan, committees have been appointed by the employees of each mine and each open pit, who first hear and decide upon the merits of any complaint or grievance that may be offered by any employee respecting underground or living conditions, hospital, or any affair in which the company may be interested. If the matter is considered unfavorably by the committee, it is dropped and goes no further. If, on the other hand, it is considered to be of a serious nature, the committee makes recommendations and refers it to higher authority. Arrangements are made for rapidly disposing of any subject or passing it up to the proper authority for disposition in a manner that is expected to meet with general approval both of employer and employee. Arrangements are also included for the reception and consideration of suggestions relative to operating methods, as well as to living and working conditions.

Other aids to tenure of service may be noted in the establishment of real coöperative stores, as at the New Cornelia, where the miner soon learns that his dollar is

buying the most possible and that the local tradesman is not living and growing fat on him; in the establishment of the building and loan association, through which it is made easy for the miner to become a property owner; and in the pension system adopted by the Copper Queen for long-time service.

Last but not least in the attainment of efficiency is to be noted the continued improvement in the prevention of accidents and in sanitation. We note nothing revolutionary in this, but a continued endeavor all along the line to educate laborers to care for themselves and their fellow men while engaged in their various tasks underground and on the surface.

On the whole, it may be said that the most notable advances in mining of the year 1918 have been, first, a marked realization on the part of employers that efficiency may be materially promoted through coöperation; second, the endeavor of employers, through various means, to stimulate this coöperation on the part of workmen; and, third, a tendency on the part of the employee to become more efficient through the better understanding that has resulted.

State Geological and Mining Officials

The following lists of the directors of state geological surveys and of the chiefs of state mine inspection bureaus constitute a convenient reference. The lists were compiled in December, 1918, from the latest information available at that time.

It will be seen that of the 48 states of the Union, 36 have organized geological surveys.

STATE GEOLOGISTS

Alabama ..... Eugene A. Smith, University.
Arkansas ..... N. F. Drake, Fayetteville.
Colorado ..... R. D. George, Director, Boulder.
Connecticut .... Herbert E. Gregory, Superintendent State Geological and Natural History Survey, New Haven.
Florida ..... E. H. Sellards, Tallahassee.
Georgia ..... S. W. McCallie, Atlanta.
Illinois ..... F. W. DeWolf, Director State Geological Survey, Urbana.
Indiana ..... Edward Barrett, Indianapolis.
Iowa ..... George F. Kay, Iowa City.
Kansas ..... Raymond Moore, Lawrence.
Kentucky ..... J. E. Barton, Commissioner of Geology and Forestry.
Maryland ..... Edward B. Mathews, Baltimore.
Michigan ..... R. C. Allen, Lansing.
Minnesota ..... W. H. Emmons, Minneapolis.
Mississippi ..... E. N. Lowe, Director, State Geological Survey, Jackson.
Missouri ..... H. A. Buehler, Director, Bureau of Geology and Mines, Rolla.
Nebraska ..... E. H. Barbour, Lincoln.
New Jersey .... H. B. Kümmel, Trenton.
New Mexico .... R. W. Ellis, Albuquerque.
New York ..... John M. Clarke, Albany.
North Carolina . Joseph Hyde Pratt, Chapel Hill.
North Dakota .. A. G. Leonard, Grand Forks.
Ohio ..... J. A. Bownocker, Columbus.
Oklahoma ..... C. W. Shannon, Norman.
Pennsylvania ... R. R. Hice, Beaver.
Rhode Island ... Charles W. Brown, Supt., Natural Resources Survey, Providence.
South Carolina . Stephen Taber, Columbia.
South Dakota .. Freeman Ward, Vermillion.
Tennessee ..... Wilbur A. Nelson, Nashville.
Texas ..... J. A. Udden, Director, Bureau of Economic Geology, Austin.
Vermont ..... G. H. Perkins, Burlington.
Virginia ..... Thomas L. Watson, Charlottesville.
Washington .... Henry Landes, Seattle.
West Virginia .. I. C. White, Morgantown.
Wisconsin ..... W. O. Hotchkiss, Madison.
Wyoming ..... L. W. Trumbull, Cheyenne.

STATE MINE INSPECTORS, COMMISSIONERS, ETC.

Alabama ..... C. H. Nesbitt, Chief Mine Inspector, Birmingham.
Alaska ..... Sumner S. Smith, U. S. Mine Inspector, Eska Creek Coal Mine, via Anchorage, care of Alaskan Eng. Commission.
Arizona ..... G. H. Bolin, Chief Mine Inspector, Phœnix; G. Montague Butler, Director, State Bureau of Mines, Tucson.
Arkansas ..... John H. Page, Commissioner, Bureau of Mines, Manufactures and Agriculture, Little Rock; John T. Fuller, State Mineralogist; Claud Speegle, State Mine Inspector, Fort Smith.
California ..... H. M. Wolflin, Chief Mine Inspector, San Francisco; F. McN. Hamilton, State Mineralogist, San Francisco.
Colorado ..... Fred Carroll, Commissioner, Bureau of Mines, Denver; James Dalrymple, Chief Inspector of Coal Mines, Denver.
Idaho ..... R. N. Bell, State Mine Inspector, Boise.
Illinois ..... John C. Thompson, Director, Department of Mines and Minerals, Springfield.
Indiana ..... John Ogilvie, Chief Mine Inspector, Indianapolis.
Iowa ..... L. E. Stamm, Secretary, State Mining Board, Des Moines.
Kansas Fred Green, State Mine Inspector, Pittsburg.
Kentucky ..... C. J. Norwood, Chief Inspector of Mines, Lexington.
Maryland ..... Lawrence Dunn, State Mine Inspector, Midland.
Michigan ..... Richard H. Fletcher, Commissioner, Department of Labor, Lansing.
Minnesota ..... F. A. Wildes, Chief Inspector of Mines, Hibbing.
Missouri ..... George Hill, Chief Mine Inspector, Bevier.
Montana ..... W. B. Orem, State Metal Mine Inspector, Helena.
Nevada ..... A. J. Stinson, State Mine Inspector, Carson City.
New Mexico .... W. W. Risdon, State Mine Inspector, Albuquerque.
New York ..... W. W. Jones, State Mine Inspector, Albany.
North Dakota .. J. W. Bliss, State Engineer, Bismarck.
Ohio ..... Jerome Watson, Chief Deputy of Mines, Industrial Commission of Ohio, Columbus.
Oklahoma ..... Ed. Boyle, Chief Mine Inspector, McAlester.
Oregon ..... H. M. Parks, Director, Bureau of Mines and Geology, Portland.
Pennsylvania ... Seward E. Button, Chief, Department of Mines, Harrisburg.
South Dakota .. Otto Ellerman, State Mine Inspector, Lead.
Tennessee ..... R. A. Shiflett, Chief Mine Inspector, Nashville.
Texas ..... B. S. Gentry, State Mine Inspector, Rockdale.
Utah ..... John A. Crawford, State Coal Mine Inspector, Salt Lake City.
Virginia ..... A. G. Lucas, State Coal Inspector of Mines, Richmond.
Washington .... James Bagley, State Inspector of Coal Mines, Seattle.
West Virginia .. W. J. Heatherman, Chief, Department of Mines, Charleston.

Chronology of Mining for 1918

JANUARY

Jan. 7—Offices and laboratory at the Omaha plant of the American Smelting and Refining Co. destroyed by fire.

Jan. 9—A premature explosion of 3000 lb. of blasting powder on Sacramento Hill, Bisbee, Ariz., killed two, fatally injured two, and seriously hurt eight men.

Jan. 10—Resolution passed by the New York Metal Exchange placing on the purchaser of tin the burden of all risks attendant on railroad and shipping delays or losses.—Mark L. Requa made head of oil division of Fuel Administration.

Jan. 14—Disastrous fire at the plant of the Chemical Products Co., at Denver, causing a loss of from $50,000 to $75,000.—Temporary injunction granted by U. S. District court at Portland, Me., upon request of the American Smelting and Refining Co., against the smelting of certain Bunker Hill & Sullivan ores in the latter's new smeltery at Kellogg, Idaho.—Resumption of operations of the High Ore and Lawrence mines, in the Butte district, after a prolonged shut-down for repairs.

Jan. 22—Copper price of 23½c. extended to June 1, 1918, following conferences of producers and War Industries Board.—Important joint meeting of the Colorado Metal Mining Association and the American Mining Congress at Denver.

Jan. 24—Price of 12c. per lb. for high-grade spelter agreed upon by producers and the War Industries Board for U. S. Government, Allied and domestic requirements until June 1, 1918.

FEBRUARY

Feb. 2—First potash land permit issued under the new law by the Secretary of the Interior, covering 2560 acres of alkaline marsh land in Inyo County, California.

Feb. 13—Seneca shaft started at Mohawk, Michigan.

Feb. 14—Accident causing four deaths occurred just below the 1100 level of the Williams shaft of Iron Cap Copper Co., at Miami, Arizona.

Feb. 16—The entire foreign commerce of the United States, including all exports and imports without exception, was made subject to control by license by President Wilson.

Feb. 18—Opening day of the 116th meeting of the American Institute of Mining Engineers in New York.

Feb. 19—Decision rendered by the U. S. Circuit Court of Appeals in San Francisco upholding previous decision rendered by Judge G. M. Bourquin, of Montana, in the case of Clark-Montana Realty and the Elm Orlu mining companies against the Butte & Superior Mining Company.

Feb. 23—Eleven men trapped in a mine cave at Amasa Porter mine, Amasa, Mich. Three were rescued.

Feb. 26—Gas-Iola plant of the Prime Western Spelter Co. partly destroyed by cyclone and fire.

MARCH

Mar. 1—Government took control of production, refining, distribution and use of crude and refined platinum for the period of the war.

Mar. 4—Price of aluminum fixed by the Government at 32c. per pound.

Mar. 5—Plant of Little Martha property, in Joplin, Mo., destroyed by fire.

Mar. 8—The trial on appeal of the Minerals Separation North American Corporation vs. the Butte & Superior Mining Co. opened at U. S. Court of Appeals at San Francisco.

Mar. 23—Decision rendered in the case of Federal Mining and Smelting Co. vs. Star Mining Co. in favor of Federal company by Judge F. S. Deitrich of the U. S. Court for the District of Idaho.

Mar. 23—List No. 1 of restricted imports issued by War Trade Board. Articles named include asbestos, graphite, pyrites, zinc, cryolite, and nickel.

Mar. 31—American Smelting and Refining Co. reopened its smelting works near Chihuahua.

APRIL

Apr. 1—Prices on iron ore, coke, steel and steel products, recommended previously by the price-fixing committee of the War Industries Board, subject to revision on Apr. 1, ordered by President Wilson to be continued in effect until July 1.

Apr. 9—Conference of wire-rope manufacturers with Mark L. Requa, head of the oil division of the U. S. Fuel Administration, decided to speed up production of the domestic wire-rope industry.

Apr. 11—Gas-Iola plant of Prime Western Spelter Co., damaged by cyclone and fire Feb. 26, resumed production of spelter.

Apr. 14—Charles M. Schwab was appointed Director General of the Emergency Fleet Corporation.

Apr. 20—Glendale plant of the Edgar Zinc Co., at St. Louis, Mo., permanently closed.

Apr. 22—Strike at smeltery of St. Joseph Lead Co. settled on terms offered originally by company.

Apr. 23—Pittman silver bill, authorizing the use of $350,000,000 in silver in the U. S. Treasury for cancellation of foreign obligations, and replacing this amount by the purchase of silver bullion at $1 per oz., signed by the President.

Apr. 25—Appointment of John D. Ryan, president of the Anaconda Copper Mining Co., to the directorship of aircraft production for the Army.

Apr. 26—British Minister of Munitions issued order taking entire control of trading in tin.

MAY

May 1—Resumption of full advances in the 90% basis on the apparent value of lead ore shipped to Consolidated Mining and Smelting Co.'s smeltery at Trail, British Columbia.

May 3—Announcement of export tax schedule in metals shipped out of Mexico effective after April 1.

May 8—Decision rendered at Tonopah, Nev. against Manhattan Morning Glory Mining Co. which was prevented from sinking shaft on White Cap Mining Co. property in an effort to follow an apex claimed by the defendant company.

May 10—First unit of Ohio Copper Co.'s new flotation plant placed in operation.

May 13—Decision of U. S. Court of Appeals rendered in the case of Minerals Separation North American Corporation vs. Butte and Superior Mining Co., the court ruling that in the use of more than 0.5% oil there is no infringement of patent.

May 15—Indictment by Federal Government of 21 citizens of the United States, residents of Bisbee, Ariz., for deportation on July 12, 1917, of 1186 I. W. W. agitators and other German propagandists.

May 18—Announcement by War Industries Board of commandeering of platinum, palladium, and iridium and the fixing of prices at $105, $135, and $175 per oz., respectively.

May 20—Overman bill, giving the President complete power for coördination of the executive work of the Government, signed by the President.

May 23—Recommended that price of copper, as fixed by Government at 23½c. per lb., be continued for 75 days beginning June 1.

May 27—Official announcement that the Mother Lode Copper Mines Co. had been taken over by interests indentified with the Kennecott Copper Corporation.

May 29—Price of aluminum fixed at a maximum base of 33c. per lb., effective to Sept. 1—Announcement of increase of 25% in freight rates and 20% increase in passenger rates of all Government-operated railroads as a result of increase in wages, amounting to $325,000,000 per annum—American Institute decided to drop all enemy aliens from membership.

May 31—Maximum base prices of Grade A zinc, sheet and plate zinc, as previously established, to be continued in effect to September 1.

JUNE

June 1—Official announcement of the schedule of prices for the manganese ores produced in the United States issued by the War Industries Board—Announcement of plans for the distribution of coal within the various states formulated by the U. S. Fuel Administration—Strike of smelters at Bartlesville, Okla.; men returned to work on June 4.

June 3—Oil producers warned by the oil division of the U. S. Fuel Administration that the Government will not at this time permit any further advance in the price of crude oil.

June 6—American Zinc Institute was formed at Joplin, Missouri.

June 7—Announced that entire production of pig iron and steel is to be distributed by the War Industries Board—Chemical Alliance pledged itself to coöperation with the chemical division of the War Industries Board in allocating and distributing sulphur-bearing materials during the war.

June 9—Rod and wire plant of the Anaconda company began operations.

June 12—Decision rendered by U. S. Supreme Court which sustained the Nevada courts in a case covering a new phase of the law of the apex, and upheld the right of the West End Consolidated to operate in both directions from the crest of a roll in its vein which formed the outcrop. Jim Butler Tonopah Mining Co. had brought suit to recover the value of ore extracted from beneath the surface of its claims.

June 13—Supreme Court of the United States denied the application for the writ of certiorari by the Butte & Superior company in its litigation with the Clark-Montana Realty Co., commonly known as the Elm Orlu-Black Rock case—Case of Louis Ross against Albert C. Burrage, vice-president of the Chile Copper Co., which involved a commission on the flotation of the Chuquicamata property, was decided in favor of Ross by the U. S. Supreme Court.

June 16—Imports of copper ore, except from Cuba or that on rail from Canada or Mexico, forbidden by War Trade Board.

June 17—U. S. Tariff Commission opened a conference with tungsten producers at Denver, Colorado.

June 20—Restrictions on the importation of Mexican labor to be used in certain specified occupations removed by an order of the Secretary of Labor—Fire destroyed the Darling 500-ton mill of Commonwealth Lead and Zinc Co., near Picher, Oklahoma.

June 21—The War Industries Board added 45c. per ton to base price of Lake Superior iron ore.

June 25—James Douglas died—Meeting of antimony producers with U. S. Tariff Commission in San Francisco—Increased freight rates became effective.

June 26—Meeting of quicksilver producers with U. S. Tariff Commission at San Francisco—Explosion of dynamite blast prematurely by lightning caused caving of a bank at Silver open-pit mine at Virginia, Minn., burying and killing 19 men.

June 27—War Industries Board announced maximum prices for sulphuric acid—U. S. Tariff Commission, sitting at San Francisco, heard arguments of chrome-ore producers.

June 28—Meeting of tungsten producers before U. S. Tariff Commission in San Francisco.

June 29—Federal Trade Commission issued a report on war profits which discussed policies and profits of mines producing copper, zinc, nickel, and sulphur.

JULY

July 2—Price of copper advanced to 26 cents.

July 3—International Nickel Co. began production at its Port Colborne, Ont., works.

July 4—Meeting of chief gold producers of British Empire at London to discuss value received for their product.

July 6—Department of Labor refuses to permit importation of Mexican labor to work in New Mexico coal mines.

July 8—International Mining Convention held at Revelstoke, British Columbia.

July 9—Control of sulphur production taken over by War Industries Board—Chemicals division and explosives division created by War Industries Board.

July 15—Meeting of petroleum producers held in San Francisco, California.

July 18—A. Mitchell Palmer, Alien Property Custodian, announced taking over of the Becker Steel Co. by the Government—First unit of United Verde Extension 500-ton smeltery blown in.

July 19—Gold mining listed as an essential industry by War Industries Board.

July 20—Importations of manganese ore from Asia and Australasia prohibited.

July 22—Meeting of stockholders of Mother Lode Copper Mines Co., of Alaska, at Seattle, Wash., ratified sale of all assets of the company to the Mother Lode Coalition Mines Co.—Seizure of certain metal firms, among them being L. Vogelstein & Co. and Beer, Sondheimer & Co., was announced by Alien Property Custodian.

July 29—First meeting of American Zinc Institute held at St. Louis, Missouri.

AUGUST

Aug. 1—U. S. Steel Corporation makes 10% wage increase effective—Committee acting under War Industries Board assumes control of sulphur-bearing materials.

Aug. 6—Meeting of "high-cost" copper producers with War Industries Board at Washington—Plant of Union Sulphur Co. at Sulphur, La., damaged by hurricane.

Aug. 8—Meeting of Colorado chapter of American Mining Congress and Colorado Metal Mining Association at Denver to discuss the gold-mining situation.

Aug. 9—President approved continuance of the 26c. price of copper.

Aug. 10—Missouri-Kansas-Oklahoma Zinc Institute formed at Joplin, Missouri.

Aug. 12—Meeting of American Mining Congress at Reno, Nev., to discuss gold production—Mexican oil decree modified so that Government is now to receive one-sixteenth of the product of every foreign-controlled well—First 500-ton unit of 1500-ton mill of Ray Hercules Copper Co., Arizona, placed in operation.

Aug. 15—Price of silver fixed at $1.01½ per fine ounce by the Government.

Aug. 20—Lead Producers' Committee issued notice to manufacturers and dealers requesting that efforts be made to eliminate non-essential uses of lead.

Aug. 21—Agreement between sheet-zinc producers and War Industries Board to maintain existing prices—British Treasury fixed price for silver at 49⅛ pence.

Aug. 27—War-Minerals Bill, introduced by Senator Henderson, proposing Government production of metals and minerals needed for the war.

Aug. 30—Suit of minority stockholders of Hull Copper Co. against Charles W. Clark settled out of court.

SEPTEMBER

Sept. 1—Opening day of American Institute of Mining Engineers' meeting at Denver, Colo.—Mining and industrial machinery exempted from import duty in Mexico.

Sept. 2—War-Minerals Bill reported to the Senate.

Sept. 3—John D. Ryan resigned as president and director of Anaconda Copper Mining Co., for the period of the war, to become Director of Air Service—Benedict C. Crowell, First Assistant Secretary of War, appointed Director of Munitions.

Sept. 5—International Gold Conference at Spokane, Washington.

Sept. 7—Fire destroyed part of the ore-roasting plant of the Trail smeltery of the Consolidated Mining and Smelting Co. of Canada.

Sept. 9—New list of preferred industries issued—Sale of gold, excepting to those holding priority orders, forbidden by the Director of the Mint.

Sept. 10—Breaking of hoisting rope at Protection Island shaft of Canadian Western Fuel Co., Nanaimo, B. C., resulting in the death of 16 miners.

Sept. 11—War-Minerals Bill passed by Senate.

Sept. 12—Registration day for selective draft—Orenstein-Arthur Koppel Co. plant sold to Pressed Steel Car Company.

Sept. 15—Works of Compañia Fundidora y Afinadora y Monterrey taken over by American Metal Company.

Sept. 16—Opening day of seventh annual meeting of National Safety Council at St. Louis, Missouri.

Sept. 17—First furnace of Anaconda's ferromanganese plant put in operation.

Sept. 18—Conference on iron and steel prices between general steel committee and War Industries Board at Washington—War Trade Board and Danish mission agree on certain exports to Denmark which include quantities of metal, minerals, and related commodities.

Sept. 23—Opening day of Fourth National Exposition of Chemical Industries at Grand Central Palace, New York.

Sept. 24—Eight-hour day adopted by U. S. Steel Corporation, effective October 1.

Sept. 30—Regulations for licensing platinum issued.

OCTOBER

Oct. 1—Increase of 25c. in the base prices of Lake Superior iron ores effective—Eight-hour basic day effective for U. S. Steel Corporation employees—Regulations for licensing platinum became effective.

Oct. 2—Henry R. Merton & Co. announced voluntary liquidation, owing to the fact that they were refused a license under the Non-Ferrous Metal Industry Act.

Oct. 5—War-Minerals Bill signed by the President—Explosion of a Government shell-loading plant at South Amboy, N. J.

Oct. 9—Utah Apex Mining Co. filed suit to restrain Utah Consolidated Mining Co. from mining ore on contested ground—American Metal Co. surrenders holdings in Consolidated Interstate-Callahan Mining Co. and cancels smelting contract with that company—Important A. I. M. E. meeting at Milwaukee, at which tin conservation was discussed by members, representatives of the Government and of many large firms.

Oct. 12—Northern Minnesota devastated by forest fires, resulting in heavy loss of lives and property and retarding iron-ore output.

Oct. 14—British Treasury fixed maximum price of 48 1/16d. per oz. for silver.

Oct. 15—Anaconda Copper Mining Co. began operation of ferromanganese plant at Great Falls, Montana.

Oct. 20—Outstanding licenses for importation of tin revoked by War Industries Board.

Oct. 25—Loss of Canadian-Pacific steamer "Princess Sophia," which foundered in the Lynn Canal, west of Juneau, Alaska, with all on board, including many mining men.

NOVEMBER

Nov. 5—Taxation of mines amendment to Utah State Constitution passed.

Nov. 6—Tin Importers' Association protested to War Industries Board against the fact that U. S. Steel Products Co. should have sole direction of the import of tin—Shipment of silver bullion to the value of $3,000,000 made from the Government Assay Office at New York to India.

Nov. 11—Armistice signed by Germany—Licenses for importation of chrome ore, except those covering shipments from Cuba, Canada, and Brazil, revoked by the War Trade Board.

Nov. 13—Monetary system of Mexico placed on a gold basis.

Nov. 15—Agreement reached between copper producers and War Industries Board that provides for maintenance of present production, prices, and wages, and regulation of prices and allocations until Jan. 1, 1919.

Nov. 16—Restrictions on domestic uses of gold and silver for industrial purposes removed by the War Industries Board—Zinc producers notified to suspend production on the filling of Government contracts.

Nov. 19—Dr. Charles R. Van Hise died.

Nov. 20—Meeting of quicksilver producers with the War Industries Board at Washington to consider prices.

Nov. 22—William G. McAdoo resigned as Secretary of the Treasury—John D. Ryan resigned as Second Assistant Secretary of War and Director of Air Service.

Nov. 25—New Cornelia Copper Co. paid initial dividend of 25c. per share.

Nov. 27—Meeting held by producers of war minerals with War Trade Board at Washington—Tin, with its alloys and compounds, removed from the Export Conservation List.

Nov. 29—Zinc-ore producers of Oklahoma, Kansas, and Missouri instituted plan of allocation, so that ore purchases may be distributed through participating mine owners.

Nov. 30—Allocation of steel stopped by the War Industries Board.

DECEMBER

Dec. 1—Capt. Joseph R. De Lamar died.

Dec. 4—Opening day of Reconstruction Conference at Atlantic City.

Dec. 5—U. S. Fuel Administration announced that its requisitions for the shipment of bituminous coal to industrial plants have been canceled.

Dec. 6—Ferromanganese plant of the Anaconda Copper Mining Co. at Great Falls, Mont., closed down—War Trade Board announced the removal of certain metals from the Export Conservation list.

Dec. 7—War Trade Board announced modification of the restriction placed on importation of ocean shipments of iron ore to permit importation of calcined spathic iron ore.

Dec. 8—Fuel oil and gas priorities abolished by U. S. Fuel Administration.

Dec. 10—Utah Consolidated Mining Co. filed suit against Utah Apex Mining Co. asking temporary restraining order and accounting and judgment for ores taken from its property.

Dec. 11—Inter-Allied Tin Executive dissolved—Meeting between American Iron and Steel Institute and the War Industries Board at Washington to discuss iron and steel prices.

Dec. 13—Suit filed against Utah State Treasurer by 20 Utah mining companies to test validity of so-called occupation tax on mines.

Dec. 14—Last brick laid on 585-ft. stack of Anaconda Copper Mining Co. at Washoe smeltery, Anaconda, Montana.

Dec. 17—Copper Export Association, Inc., formed.

Dec. 20—Lead Producers' Committee met in New York and decided to dissolve and let a free market be instituted—War Industries Board announced price regulations of copper industry would cease Jan. 1.

Dec. 22—One miner killed in cave-in of drift at the Negaunee mine, Negaunee, Mich. Three miners were rescued after 63 hours' entombment.

Dec. 23—War Trade Board announced the removal of restrictions on tin and tin plate.

Dec. 24—Anaconda reduced its quarterly dividend from $2 to $1.50 per share.

Dec. 31—R. W. Raymond died.

New Mining and Metallurgical Construction In 1918

National Steel Products Co., Bessemer, Jefferson County, Ala., began 25-ton steel castings plant.

Sloss-Sheffield Steel and Iron Co., Birmingham, Jefferson County, Ala., erecting 120 Semet-Solvay byproduct coke ovens at North Birmingham at an approximate cost of $5,000,000.

Tennessee Coal, Iron, and R.R. Co., Birmingham, Jefferson County, Ala., completed repairs on Little Belle furnace at Bessemer and completed 110-in. plate mill at Fairfield.

Shelby Chemical Co., Shelby, Shelby County, Ala., completed byproduct plant at a cost of $600,000.

Central Alabama Coal and Iron Co., Jenifer, Talladega County, Ala., rehabilitated iron furnace plant, erected hot-blast stove and installed electrical equipment and built additional brown-ore washery.

Fairbanks Gold Mining Co., Fairbanks, Alaska, placed dredge, built by the Union Construction Co., in operation.

Alaska Juneau Gold Mining Co., Juneau, Alaska, making alterations and enlargements to mill to increase daily capacity to 8000 tons.

Saltchuck Mine, Ketchican, Alaska, installed 100-ton concentration and flotation mill.

North Midas Copper Co., Strelna, Alaska, built cyanide plant for treatment of gold and silver ores. Estimated cost of plant, $80,000.

Copper Queen Branch, Phelps Dodge Corporation, Bisbee, Cochise County, Ariz., cleared site for 5000-ton concentrator and is stripping ore overburden.

Shattuck-Arizona Copper Co., Bisbee, Cochise County, Ariz., completed a 400-ton mill at a cost of $240,000.

American Smelting and Refining Co., Hayden, Gila County, Ariz., completed installation of coal-crushing plant and new fumes stack.

Miami Copper Co., Miami, Gila County, Ariz., completed new four-compartment concrete working shaft No. 5 to 875 ft.; concreted No. 3 shaft, for fire protection, to 420 ft.; installed 200,000-cu.ft. fan; remodeled five of six mill units to enlarge capacity to 6000 tons daily; constructed 100-ton experimental plant for working out plan of treatment of oxidized ores and installed two 600-hp. boilers and two 4000-kw. turbo-generators for additional mill power required.

Lavelle Gold Mining Co., Winkleman, Gila County, Ariz., began construction of 50-ton mill to cost $60,000. First unit expected to be completed in January, 1919.

Arizona Copper Co., Ltd., Clifton, Greenlee County, Ariz., installed 16 Deister tables at No. 4 concentrator, and erected 15-ton experimental leaching plant. At its No. 6 concentrator, Morenci, the company installed 12 Allen cones, 12 Dorr classifiers and 3 Dorr tanks. Also built and equipped an experimental 400-ton mill for the treatment of low-grade ores. Completed 500-locker change house.

Detroit Copper Mining Co., Morenci, Greenlee County, Ariz., replaced gas engine at concentrator with two Deisel engines of large capacity.

Emerald Isle Copper Co., Chloride, Mohave County, Ariz., completed additional precipitation unit to increase product by 2060 lb. daily.

Gold Road Mines Co., Goldroad, Mohave County, Ariz., built 300-ton crushing plant.

Hackberry Silver Mining Co., Hackberry, Mohave County, Ariz., completed 200-ton concentrator and power plant at an estimated cost of $200,000.

Arizona Ore Reduction Co., Kingman, Mohave County, Ariz., completed 250-ton concentrator, roaster and separation unit; also a million-gallon reservoir.

Standard Minerals Co., Kingman, Mohave County, Ariz., completed 50-ton test mill for flotation of molybdenite ores.

McCracken Silver-Lead Mines Co., Yucca, Mohave County, Ariz., built 100-ton dry concentrating mill.

Yucca Tungsten Mining Co., Yucca, Mohave County, Ariz., completed 60-ton mill.

New Cornelia Copper Co., Ajo, Pima County, Ariz., erecting 500-ton experimental plant for flotation of sulphide ores.

Red Chief Mining and Milling Co., Casa Grande, Pinal County, Ariz., completed 50-ton mill, which uses Elsol type of dry concentrators.

United States Vanadium Development Co., Kelvin, Pinal County, Ariz., completed Bryan dry classifier and 50-ton concentrator. Plant cost about $50,000. Construction began October, 1917, and was finished Mar. 5, 1918.

Ray Consolidated Copper Co., Ray, Pinal County, Ariz., erected new brick office and shaft buildings; installed new compressor system for underground haulage, now nearly complete, and concreted main haulage tunnel.

Ray Hercules Copper Co., Ray, Pinal County, Ariz., completed 1500-ton concentrator and Diesel power plant at Hercules, seven miles from mine, also power line to mine, large skip hoist, crushing plant, concrete ore bins, sampler, and machine shop, at main shaft head and several miles of railroad and a steel bridge across Mineral Creek.

Silver King of Arizona Mining Co., Superior, Pinal County, Ariz., installed small crushing plant.

Flux Mine, Patagonia, Santa Cruz County, Ariz., installed 300-ton mill.

World's Fair Mine, Patagonia, Santa Cruz County, Ariz., installed 100-ton tube mill and 225-ton concentrator.

Octave Mines Co., Congress Junction, Yavapai County, Ariz., began construction of a 250-ton gold reduction plant.

Verde Inspiration Co., Dewey, Yavapai County, Ariz., made additions to stamp mill and built flotation and cyanidation plant.

Consolidated Arizona Smelting Co., Humboldt, Yavapai County, Ariz., completed new roaster plant at cost of $300,000, including four Wedge furnaces, with Cottrell treaters and electric precipitation installation. Also completed converter stack, 190 ft. high, costing $20,000.

United Verde Copper Co., Jerome, Yavapai County, Ariz., completing extensive house-building program at Jerome and Clarkdale; completed loading station, with electrical equipment, at 1000 level of main shaft, and is completing new switchback railroad up to former smeltery site above Jerome, where ore croppings are being handled by steam shovels.

United Verde Extension Copper Co., Jerome, Yavapai County, Ariz., completing smeltery at Verde. Blast furnace in operation; two reverberatories under construction. Completing 12,000-ft. haulage tunnel and ore pockets at shaft. Working on large housing plans at Jerome and Verde.

Pocahontas Copper Queen Mining Co., Mayer, Yavapai County, Ariz., began construction on a 50-ton unit of flotation plant to cost $25,000.

Swansea Consolidated Gold and Copper Mines Co., Swansea, Yuma County, Ariz., completed 250-ton plant for flotation of sulphide copper ores.

Washing Plants built in the Batesville, Ark., manganese field during 1918 were: 500-ton plant at the Cutter mine; 200-ton plant at the Polk-Southard mine, operated by the Independence Mining Co., and a smaller one on the company's property on Lafferty Creek; 300-ton plant at the Adler mine; 300-ton plant at the U. S. Canadian and a 300-ton plant at the Oklahoma-Kansas mine, all of these near Cushman, Ark. Near Batesville the Waco Mining Co. erected a 250-ton plant at the Patterson mine and a 250-ton plant at the Bilharz mine. The Leader Mining Co. completed a 250-ton plant at the Allen mine, and a small plant was built by Shepherd and Wilson at their Ball mine. Plants under construction are two 200-ton mills on the Napoleon Hill land, at Cushman, under operation by Beatty and associates; a 300-ton plant at the Pugh Hollow mine operated by the Everton Mining and Development Co. at Cushman, and a 300-ton plant at the mine of the Liberty Manganese Co. At Batesville, a 250-ton plant is under construction at the Ball mine.

Western Magnesite Co., Livermore, Alameda County, Calif., installed 150-ton mill.

California National Gold Mining Co., Oroville, Butte County, Calif., installed 1500-ton concentrator.

Western Ore Co., Oroville, Butte County, Calif., constructed 50-ton concentration plant at Lime Saddle; also 1400-ft. tramway. Equipment used in treatment of low-grade chrome ores.

Napoleon Copper Co., Copperopolis, Calaveras County, Calif., completed 90-ton plant consisting of ball mills, flotation unit, and concentrators.

Consolidated Wilshire Mining Co., Bishop, Inyo County, Calif., installed 80-ton flotation plant. Test run made Dec. 7, 1918.

Pine Creek Tungsten Mining Co., Bishop, Inyo County, Calif., installed 225-ton mill.

Tungsten Mines Co., Bishop, Inyo County, Calif., installed 150-ton flotation plant for treatment of tungsten ores.

Saline Valley Salt Co., Keeler, Inyo County, Calif., completed aërial tramway from mill to railroad.

Round Valley Tungsten Co., Pine Creek, Inyo County, Calif., built 150-ton mill.

Gold State Mine, Caliente, Kern County, Calif., installed 30-ton mill.

Mount Gaines Gold Mining Co., Hornitos, Mariposa County, Calif., completed installation of 100-hp. electric hoist, and made improvements in mill.

Empire Mines and Investment Co., Grass Valley, Nevada County, Calif., built two retaining reservoirs for mill tailings.

Grass Valley Consolidated Gold Mines Co., Grass Valley, Nevada County, Calif., completed construction of mill and cyanide plant of 29,000 tons' annual capacity at a cost of $225,000.

North Star Mines, Grass Valley, Nevada County, Calif., installed 1225-ft. aërial cable operating clam-shell bucket for handling tailings.

Sierra Asbestos Co., Washington, Nevada County, Calif., built tramway between mine and mill, remodeled mill and constructed three-span bridge over Yuba River.

Parker Chrome Co., Auburn, Placer County, Calif., completed mill for crushing ore.

Placer County Chrome Co., Auburn, Placer County, Calif., enlarged concentration plant and installed machinery.

Engles Copper Co., Keddie, Plumas County, Calif., installed 750-ton flotation plant.

Geisendorfer and Farmer, Folsom, Sacramento County, Calif., installed 50-ton mill for treatment of chrome ores.

Noble Electric Steel Co., Folsom, Sacramento County, Calif., installed mill for crushing and concentrating low-grade chrome ores.

Pacific Electric Metals Co., Stockton, San Joaquin County, Calif., installed 40-ton electric furnace for making ferromanganese at Bay Point.

Santa Margarita Chrome Co., Santa Margarita, San Luis Obispo County, Calif., completed installation of 75-ton concentrator at a cost of $20,000.

Afterthought Copper Co., Ingot, Shasta County, Calif., completed construction of cottages for employees, made improvements in 400-ton flotation plant, and completed electrolytic zinc plant and reverberatory furnace.

Mountain Copper Co., Keswick, Shasta County, Calif., increased flotation plant at Minnesota station by 300-ton unit.

American Gold Dredging Co., Redding, Shasta County, Calif., constructed 132-ft. dredge with 6-cu.ft. buckets.

Bully Hill Copper Mining and Smelting Co., Winthrop, Shasta County, Calif., converted old smeltery into 150-ton flotation plant.

Brandy City Mining Co., Brandy City, Sierra County, Calif., completed 300-ft. dam on north fork of the Yuba River.

Index Gold Mining Co., Quimby Creek, Trinity County, Calif., completed 50-ton gold mill.

Kleinsorge Chrome Mine, Lowrey, Tehama County, Calif., installed ten 850-lb. stamps and two concentrating tables.

Elder Creek Chrome Co., Red Bluff, Tehama County, Calif., installed crushing and concentration plant.

Pacific Coast Gold Mines Corporation, Quartz, Tuolumne County, Calif., building stamp and fine-grinding mill of 180,000 tons' annual capacity. To be completed by January, 1919.

Tonopah Belmont Development Co., Shawmut, Tuolumne County, Calif., completed stamp, flotation, and cyanide mill of 144,000 tons' annual capacity.

Confidence Gold Mines Corporation, Sonora, Tuolumne County, Calif., installed ball mill, tube mill, 10-tank cyanide plant, and other equipment.

Federal Gold Mining Co., Sonora, Tuolumne County, Calif., installed 50-ton Huntington mill.

Golden Age Mining and Reduction Co., Jamestown, Boulder County, Colo., installed 120-ton flotation plant.

Wano Mining and Milling Co., Jamestown, Boulder County, Colo., added three tables to mill treating fluorspar.

K. K. Mining and Milling Co., Alice, Clear Creek County, Colo., completed 50-ton amalgamating and concentrating mill at a cost of $10,000.

Colorado Central Mining Co., Georgetown, Clear Creek County, Colo., completed construction of 150-ton flotation plant to treat dumps.

Sceptre Mines and Mills Co., Georgetown, Clear Creek County, Colo., completed 7000-ft. aërial tram from mine to loading station on Colorado and Southern Ry.; also new ore bins, boarding house, and bunk house for 50 men at the mine.

Idaho Mining, Reduction, and Transportation Co., Idaho Springs, Clear Creek County, Colo., added new 100-ton flotation unit to mill.

Little Giant Mining and Milling Co., Lawson, Clear Creek County, Colo., completed mill.

Primos Chemical Co., Urad, Clear Creek County, Colo., completed new boarding house, bunk house, 200-ton mill, and 2400-ft. tramway.

Buffalo Hunter Mining and Milling Co., Silver Cliff, Custer County, Colo., completed 100-ton mill.

General Reduction Co., De Beque, Garfield County, Colo., installed 50-ton unit of Scott process to treat oil shale.

Mount Blaine Oil Shale Products Co., De Beque, Garfield County, Colo., built 100-ton oil-distillation plant.

Fanny Rawlings Mining Co., Leadville, Lake County, Colo., rebuilt surface plant and installed electric hoist.

Radium Ore Sampling Co., Montrose, Montrose County, Colo., completed rare-ore custom sampler at a cost of $12,000.

Ouray Custom Milling Co., Ironton, Ouray County, Colo., installed table and flotation machinery.

Calliope Consolidated Mining Co., Ouray, Ouray County, Colo., installed power plant and compressor.

Mountain Top Mining Co., Ouray, Ouray County, Colo., completed 3000-ft. tramway from mine to Governor Basin.

Yellow Jacket Mines Co., Ouray, Ouray County, Colo., completed mill.

Norcross Chemical Co., Pueblo, Pueblo County, Colo., installed chemical plant for sulphuric-acid manufacture.

Sunnyside Mining and Milling Co., Eureka, San Juan County, Colo., completed 500-ton flotation mill, 16,000 ft. of tramway, mining plant, and power line.

Lackawanna Mining and Reduction Co., Silverton, San Juan County, Colo., completed new tramway, installed new mining machinery, and remodeled mill.

Lewis Mine Co., Telluride, San Miguel County, Colo., made alterations to mill and installed flotation plant for treatment of lead-zinc-copper ore.

Belmont Wagner Mining Co., Telluride, San Miguel County, Colo., completed 300-ton mill.

Liberty Bell Gold Mining Co., Telluride, San Miguel County, Colo., remodeled mill to treat concentrates.

Liberty Leasing Co., Breckenridge, Summit County, Colo., remodeled mill and installed flotation unit at Monte Cristo mine.

Power River Dredging Co., Breckenridge, Summit County, Colo., installed new transformers and new dredge built by the Yuba Construction Company.

Molybdenum Products Co., Buffehrs, Summit County, Colo., completed 250-ton mill.

Climax Molybdenum Co., Climax; Summit County, Colo., completed 400-ton mill; 500 ft. two-bucket tramway; 5000 ft. aërial tramway, and crushing plant.

Minerals Products Co., Frawley, Summit County, Colo., completed 200-ton milling plant to treat molybdenum ores.

Big Toad Mining and Milling Co., Cripple Creek, Teller County, Colo., remodeled Reid mill.

Mary McKinney Mining Co., Cripple Creek, Teller County, Colo., installed steam hoist and drag-line excavator at the Howard shaft.

Vindicator Consolidated Gold Mining Co., Cripple Creek, Teller County, Colo., is installing additional equipment to double capacity of ferro-alloy plant purchased from the Ferro-Alloy Co. of Denver.

Excelsior Mining, Milling and Electric Co., Victor, Teller County, Colo., erected new ore house at shaft of Longfellow mine.

Akron Mines, Whitepine, Whitepine County, Colo., installed electric power line and rebuilt mill.

Chestatee Pyrites and Chemical Co., Chestatee, Hall County, Ga., completed 600-ton sorting and concentration plant and enlarged hydroelectric power plant.

Falls Creek Mining Co., Sandpoint, Bonner County, Idaho, began installation of a concentrator having a capacity of 20,000 tons per year and to cost $40,000.

Armstead Mines Corporation, Talache, Bonner County, Idaho, completed 100-ton mill.

Empire Copper Co., Mackay, Custer County, Idaho, completed three-mile tramway from mine to railroad.

Bunker Hill & Sullivan Mining and Concentrating Co., Kellogg, Shoshone County, Idaho, at its smeltery, completed Cottrell precipitation plant, added three Dwight & Lloyd sintering machines, made additions to blower house, added 1100-cu.ft. compressor, and completed coal pulverizing plant; also made extensions to lead refinery. Remodeled old Sweeny mill at Bradley, to treat 600 tons daily of coarse tailings from the Last Chance mine.

Cœur d'Alene Antimony Mining Co., Kellogg, Shoshone County, Idaho, completed K. & K. flotation plant.

Throndson Metal Saving Co., Kellogg, Shoshone County, Idaho, completed 200-ton concentrating and flotation mill.

Spokane Metals Recovery Co., Mullan, Shoshone County, Idaho, completed 200-ton mill, which was destroyed by fire in September.

Blewett Mining Co., Galena, Jo Daviess County, Ill., began construction of 600-ton zinc concentrating mill at an estimated cost of $52,000 in August. To be completed January, 1919.

American Zinc Products Co., Greencastle, Putnam County, Ind., completed modern zinc-rolling mill of 1000 to 1500 tons' daily capacity.

Zimmerman Steel Co., Bettendorf, Scott County, Iowa, installed a five-ton three-phase electric furnace.

Calumet & Hecla Mining Co., Calumet, Mich., increased capacity of Lake Linden leaching plant by substituting Hardinge mills for Chilean mills; installed 250 forty-ton cars; completed 10,000-kw. power house and office building at Lake Linden; installed electric furnace for making stamp shoes; began construction of 2000-ton flotation plant.

Seneca Mining Co., Calumet, Mich., completed surface buildings, shafthouse and power plant.

Quincy Mining Co., Hancock, Mich., completed dwelling houses and began making additions to stamp mill at Mason.

Lake Milling, Smelting and Refining Co., Point Mills, Mich., built two additional stamp heads.

White Pine Extension Copper Co., Pinex, Mich., installed Minerals Separation machines.

Charcoal Iron Co., Bessemer, Mich., began erection of complete new surface plant at the Yale mine.

Oliver Iron Mining Co., Ironwood, Mich., completed electric plant at Pabst mine, which is to be used as a central power station for the company mines on the Gogebic Range.

Cleveland Cliffs Iron Co., Ishpeming, Mich., built surface plant at Barnes-Hecker mine; at Marquette rebuilt refining house at Pioneer Iron Co. furnace, destroyed by fire; installing hydroelectric power plant at Forestville to generate 5000 kw., to be completed February, 1919.

Cuyuna-Minneapolis Iron Co., Crosby, Minn., completed shaft, built engine house, dry-house and dwellings at Ida Mae mine.

Northern Minnesota Ore Co., Cuyuna, Minn., began sinking of 10 x 16 ft. three-compartment shaft, and built office, dry-house, shops, and dwellings at Northland mine.

Breitung & Co., Ironton, Minn., completed sinking of shaft and erection of buildings at Hopkins' mine in July.

American Manganese Manufacturing Co., Ironton, Minn., completed three-compartment shaft, began in 1917, in August; also erected steel headframe, built surface plant and machinery at Cuyuna-Mille Lacs mine. Sunk shaft deeper and installed new compressor at the Cuyuna-Duluth mine.

Arko Mining Co., Ironton, Minn., completed in September, two-compartment shaft at the Arko mine. Also erected headframe and mine buildings.

Bessemer Iron Co., Ironton, Minn., sunk shaft and installed machinery, but closed down in April. Machinery and supplies sold and buildings dismantled.

Cuyuna-Suitana-Oneida Mines Co., Ironton, Minn., completed 2000-ton manganiferous iron-ore washing plant in August.

Inland Steel Co., Ironton, Minn., completed new office building in November.

Liberty Mining Co., Ironton, Minn., sunk shaft, erected headframe and surface buildings at the Bonnie Belle mine.

Whitemarsh Mining Co., Ironton, Minn., completed sinking of shaft, built shops, headframe, and dwellings, and installed machinery at the Martin mine. Completed shaft and hoist equipment at Huntington mine.

Coates & Tweed, Manganese, Minn., began sinking shaft at Preston mine, but closed down same Dec. 1, pending labor and ore-price developments. Built dry-house, shops and engine and boiler house and installed machinery.

Adbar Development Co., Trommald, Minn., began sinking shaft in August. Temporary surface plant, but no permanent improvements.

Gloria Mining Co., Trommald, Minn., installed hoist, compressor, and pumps at Gloria mine, formerly known as McKenzie mine. Closed down December 2.

Joan Mining Co., Trommald, Minn., began sinking drop shaft at Joan No. 3 mine in June. Temporary buildings erected.

Merritt Development Co., Trommald, Minn., completed three new shafts at Merritt mine. Erected headframes, built railroad spurs, and installed machinery, completing construction in October.

Onahman Iron Co., Trommald, Minn., at its Algoma mine, changed from steam to electrical equipment and installed 200-hp. oil engine auxiliary and new pumping equipment.

Oneida Mines Co., Trommald, Minn., began sinking of drop shaft at Clark mine, and erected boiler and engine house, dry-house, and surface buildings.

Omaha Iron Co., Woodrow, Minn., erected drying plant at the Wilcox mine. Construction began March, 1918, and was completed in July.

Interstate Iron Co., Calumet, Minn., began construction of two-unit washing plant at the Hill Annex mine; capacity, 1000 tons daily.

Picklands, Mather & Co., Calumet, Minn., constructed office, camps, and blacksmith shop at the Majorca mine; completed concentrating plant at Riley Lake on May 1.

Duluth, Missabe & Northern Ry., Duluth, Minn., completed No. 6 ore dock at a cost of $2,500,000. New approaches were built to No. 3 and No. 4 docks.

M. A. Hanna & Co., Hibbing, Minn., built new office building.

Draper Mine, Marble, Minn., completed concentrating plant.

Oliver Iron Mining Co., Virginia, Minn., completed 470-ft. coal dock at Missabe Mountain mine; added seventy 20-cu.yd. air-dump cars to stripping equipment; Hibbing, Minn., completed small gravity screening plant at Hull Rust mine to separate waste and ore; Eveleth, Minn., began concentration and crushing plant at the Leonidas mine.

Bannack Mining and Milling Co., Bannack, Beaverhead County, Mont., completed milling plant of 9000 tons' annual capacity.

Boston & Montana Development Co., Elkhorn, Beaverhead County, Mont., built 500-ton mill.

Anaconda Copper Mining Co., Great Falls, Cascade County, Mont., completed copper rod and wire plant; completed electrolytic ferromanganese plant, consisting of five furnaces, at a cost exceeding $500,000. Plant closed down on Dec. 6. Completed 585-ft. stack at Washoe smeltery, Anaconda.

Cascade Mine, Neihart, Cascade County, Mont., completed 500-ton mill for the treatment of lead-silver sulphide ores.

Phillipsburg Mining Co., Phillipsburg, Granite County, Mont., completed 400-ton mill for the treatment of low-grade manganese ores by magnetic separation.

Alta Mining Co., Corbin, Jefferson County, Mont., completed new electric power plant to replace Bertha plant destroyed by lightning.

Economy Gold Mines Co., East Helena, Lewis and Clark County, Mont., completed 100-ton concentrator.

New York-Montana Testing and Engineering Co., Helena, Lewis and Clark County, Mont., increased plant for treating manganese to 100 tons' capacity.

Porphyry Dike Gold Mining Co., Rimini, Lewis and Clark County, Mont., completed 300-ton mill for treatment of free gold ores.

Liberty Mining Co., Silver Camp, Lewis and Clark County, Mont., repaired 100-ton mill to treat lead-zinc ores.

Tarbox Mining Co., Saltese, Mineral County, Mont., completed 300-ton mill for the treatment of zinc-lead ores.

Crystals Goldsmith Co., Butte, Silver Bow County, Mont., installed 75-hp. electric hoist and 1000-cu.ft. compressor at the Tong shaft; also surface plant buildings.

United States Manganese Corporation, which took over the Ophir mill of the Butte-Detroit Copper and Zinc Mining Co., Butte, Silver Bow County, Mont., added further equipment to mill for treatment of silver-zinc and manganese ores. Mill and mine closed down.

Hoosier Del Monte Mining Co., Goodsprings, Clark County, Nev., completed 50-ton concentrator for treatment of low-grade lead-silver ore.

Sultan Mine, Goodsprings, Clark County, Nev., enlarged dry concentrating plant.

Rochester Combined Mines Co., Rochester, Humboldt County, Nev., completed installation of leaching vats and part of grinding plant of 500-ton cyanide leaching installation.

Nevada-Humboldt Tungsten Co., Tungsten, Humboldt County, Nev., completed 100-ton tungsten mill, consisting of crushers, rolls, jigs, Deister-Overstrom tables, driers, and magnetic separators.

Pacific Tungsten Co., Tungsten, Humboldt County, Nev., completed 125-ton mill, which began operation in November.

Bluestone Mining and Smelting Co., Yerrington, Lyon County, Nev., completed 400-ton flotation plant in April at a cost of $300,000.

Silver Dike Tungsten Mine, Mineral County, Nev., completed 30-ton mill for treating high-grade scheelite ore.

Kansas City-Nevada Consolidated Mining Co., Bruner, Nye County, Nev., began installation of 50-ton mill and nine-mile pipe line.

White Caps Mining Co., Manhattan, Nye County, Nev., completed changes to mill.

Nevada-California Power Co., Tonopah, Nye County, Nev., completed electric power line to camp of Divide.

Consolidated Coppermines Co., Kimberly, White Pine County, Nev., completed second 500-ton section of mill.

Thomas Iron Co., Wharton, Morris County, N. J., sunk three-compartment shaft to 1100 level; installed new headframe, hoisting plant, and magnetic cobbing mill at the Richard mine.

Wharton Steel Co., Wharton, Morris County, N. J., completed 2500-ton magnetic concentrating mill at the Scrub Oak mine.

Vera Cruz Leasing Co., Carizozo, Grant County, N. M., installed crusher, ball mill, amalgamators and thickening tanks at a cost of $20,000.

85 Mining Co., Lordsburg, Grant County, N. M., constructed 300-ton mill and new hoist.

Last Chance Mining Co., Lordsburg, Grant County, N. M., completed 50-ton unit of mill.

Calumet Mining Co., Silver City, Grant County, N. M., began construction of lead-zinc concentrating mill, to have an annual capacity of 30,000 tons.

Chateaugay Ore and Iron Co., Lyon Mountain, Clinton County, N. Y., began construction of a new magnetic concentrating mill having a capacity of 100 tons per hour.

St. Nicholas Zinc Co., Summitville, Sullivan County, N. Y., made additions and improvements to mill.

Tri-State Chrome Mining Co., Canyon City, Grant County, Ore., remodeled 80-ton mill of Jupiter Mining Company.

Ranier Mercury Co., Gold Hill, Jackson County, Ore., erected 12-pipe mercury furnace.

Gold Hill Mining Association, Nedford, Jackson County, Ore., installed 10-stamp mill.

Alameda Copper Mines, Grants Pass, Josephine County, Ore., built 200-ton concentrator and 150-ton reduction furnace.

Rare Minerals Co., Custer, Custer County, S. D., installed a 50-ton concentrator that will be placed in operation soon after the first of the year to handle tin and tungsten ores.

Spokane Lead Co., Hermosa, Custer County, S. D., completed 100-ton concentrator and placed same in operation in July.

Cutting Mining Co., Deadwood, Lawrence County, S. D., began construction of shafthouse, electric hoist, and compressor.

Deadwood Lead and Zinc Mining Co., Deadwood, Lawrence County, S. D., completed 10-stamp mill and concentrator in August.

Mogul Mining Co., Terry, Lawrence County, S. D., completed aërial tramway from portal of main working tunnel to mill bins, a distance of 1600 feet.

American Tin and Tungsten Co., Hill City, Pennington County, S. D., remodeled tin mill. Plant to be ready for concentration by March 1, 1919, and is to have from 75 to 250 tons' capacity. Installed 60-hp. hoist at Cowboy mine.

Metal Products Association of Texas, Alpine, Brewster County, Tex., began construction of 50-ton copper blast furnace.

Mariposa Mining Co., Terlingua, Brewster County, Tex., installed furnace to treat low-grade quicksilver ores.

Southwestern Graphite Co., Burnet, Burnet County, Tex., built 200-ton electrostatic plant for graphite concentration.

National Potash Corporation, Devils Slide, Morgan County, Utah, made alterations in Union Portland Cement Co. plant to produce potash from Wyoming leucite rock.

Chief Consolidated Mining Co., Eureka, Juab County, Utah, added 2500-cu.ft. Laidlaw-Dun-Gordon compressor and Worthington pumps. Began three-compartment, concrete-lined shaft July 1. To be 2000 ft. deep.

Deer Trail Mining Co., Marysvale, Piute County, Utah, completed 100-ton flotation and cyanide mill for treatment of gold-silver-lead ore.

Florence Mining and Milling Co., Marysvale, Piute County, Utah, completed 100-ton unit of alunite mill and installed roasting furnace and leaching plant.

Mineral Products Co., Marysvale, Piute County, Utah, rebuilt 200-ton mill for treatment of alunite.

Sells Mine, Alta, Salt Lake County, Utah, built and put in operation a 2000-ft., 100-ton tramway.

Ohio Copper Co., Bingham Canyon, Salt Lake County, Utah, completed 3000-ton flotation plant.

Little Cottonwood Transportation Co., Wasatch, Salt Lake County, Utah, completed eight-mile, 36-in. gage railroad from Wasatch to Alta.

Big Indian Copper Co., Lasal, San Juan County, Utah, completed 200-ton mill for copper ores. After short operation, mill was remodeled.

Judge Mining and Smelting Co., Park City, Summit County, Utah, made additions and improvements to zinc plant of 30-ton capacity.

Silver King Consolidated Mining Co., Park City, Summit County, Utah, completed 150-ton mill for silver-lead-zinc ores.

Utah Mine, Fish Springs, Tooele County, Utah, nearly completed 100-ton mill for silver-lead ores.

Western Utah Copper Co., Gold Hill, Tooele County, Utah, began 100-ton mill to treat copper ore.

American Fork Exploration Co., American Fork, Utah County, Utah, completed small mill.

American Mineral Co., Johnson, Lamoille County, Vt., completed installation of hydroelectric mill for treatment of talc.

Crimora Manganese Corporation, Crimora, Augusta County, Va., remodeled mill to treat 50 tons daily of manganese ore.

Roanoke Ore and Iron Co., Roanoke County, Va., constructed 12 miles of railroad and a washing plant for iron ores.

Stange Mine, Narrows, Giles County, Va., completed mill of 75,000 tons' annual capacity to handle manganese ores.

Great Metals Mining and Milling Co., Nespelem, Okanogan County, Wash., completed 100-ton concentrator.

Copper World Extension Mining Co., Nighthawk, Okanogan County, Wash., began two-mile tramway from Copper World and Copper World Extension mines to Palmer Lake.

Ivanhoe Mining Co., Oroville, Okanogan County, Wash., completed 50-ton flotation plant.

Metalene Oriole Mining Co., Metalene, Pend Oreille County, Wash., erected 50-ton mill to treat lead-zinc-silver-gold ores.

Young America Mine, Bossburg, Stevens County, Wash., began construction of a 50-ton concentrator.

Northwest Magnesite Co., Chewelah, Stevens County, Wash., completed five-mile aërial tramway from Finch quarry to Chewelah, grinding and mixing plant, and pulverizing plant.

Electric Point Mining Co., Northport, Stevens County, Wash., completed 2¼-mile tramway at a cost of $45,000.

Northport Smelter Co., Northport, Stevens County, Wash., completed drossing plant.

Zinc Hill Mining Co., Cuba, Wis., completed 100-ton zinc concentrating mill at the Little Dick mine. Construction started Aug. 1, and was completed Nov. 15. Estimated cost, $40,000. Also began construction of 300-ton mill at Big Dick mine on Dec. 2.

United States Government started construction of acid plant, capacity 100 tons oleum per 24 hours, at the National Zinc Separating Plant, Cuba, Wis. Construction began July 15, and about 80% of work was completed when it was ordered discontinued by the Government. Began construction of an acid plant of a capacity of 50 tons of oleum per 24 hours at the Skinner roaster of the Wisconsin Zinc Co., New Diggings, Wis. Construction started July 15, but was ordered stopped at the end of the year.

Connecting Link Mining Co., Jenkynsville, Wis., completed 150-ton mill at an estimated cost of $41,000. Work was started November, 1917.

Lucky Six Mining Co., Linden, Wis., completed, in April, 50-ton zinc concentrating mill which was started November, 1917.

Vinegar Hill Zinc Co., Livingston, Wis., completed 350-ton mill at the Dale Rundell mine at an estimated cost of $65,000.

Little Platte Lead and Zinc Co., Platteville, Wis., completed 75-ton zinc concentrating mill in October.

Wisconsin Zinc Co., Shullsburg, Wis., completed Copeland mill having a capacity of 250 tons. Construction was started in November, 1917, and was completed March 1, 1918.

Dolly Varden Mines Co., Alice Arm, B. C., constructed 15 miles of railroad from beach to mine. No estimate of cost available. Installation of 150-ton concentrator and 750-hp. power plant proposed during 1919.

Granby Consolidated Mining, Smelting, and Power Co., Anyox, B. C., began construction in April of 30-oven byproduct coke plant and benzol plant at Graves Point. Completed work at Anyox smeltery, including two new converters, construction of which was started in July, 1917.

Pacific Coast Contractors, Ltd., Cariboo Road, Clinton Mining Division, B. C., installed evaporating plant for the treatment of water at Soda Lake, which carries 6% sodium carbonate. Capacity three tons of crystal soda per day.

Tertiary Gravel Co., Cottonwood Canyon, Fraser river, north of Quesnel, B. C., began remodeling of mill, to treat cemented gold-bearing gravel. Capacity, 50 tons a day.

Drum Lummon Copper Co., Drum Lummon Bay, Douglass Channel, B. C., completed installation of 36-ton experimental Gibson mill and concentrator.

French Complex Ore Reduction Co., Fairview, near Nelson, B. C., completed electrolytical plant for experimental treatment of complex silver-lead-zinc ores of eastern section of province. Government, in 1917, voted $25,000 for improvement of works and to aid in starting operations.

Lanark Mining Co., Illecillewaet, B. C., installed 250-hp. hydroelectric plant to drive mill and furnish power for mine.

Sunloch Mining Co., Ltd., Jordan river, West Coast, Vancouver Island, B. C., started construction of a wagon road and the installation of a compressor plant. Estimated cost, $65,000. Capacity of plant, 30,000 tons per year.

Queen Bess Mines, Inc., near Kamloops, B. C., began installation of concentrating plant.

Cork-Province Mines, Ltd., Kaslo, B. C., installed ball mill and flotation plant at a cost of $15,000.

Outsider Group, Maple Bay, Portland Canal, B. C., installed small compressor plant.

Silver Standard Mining Co., New Hazelton, B. C., completed 50-ton mill. Cost of mill estimated between $30,000 and $35,000. Construction started late in 1917, and was finished June, 1918.

Aetna Iron and Steel Co., Port Moody, B. C., installed six-ton electric pig-iron furnace.

Canada Copper Corporation, Princeton, B. C., continued construction of 300-ton concentrator, 15 miles of railroad, and power line, involving total expenditure of $4,500,000, of which $2,000,000 is being spent by Canadian Pacific interests.

South Easter Group, Skidegate, Graham Island, B. C., installed compressor and hoist.

Efanjay Gold Mining Co., Tulameen River, B. C., built dam and flume for recovery of gold and platinum of gravel from river bed at a cost of $20,000.

Rex Mines, The Pas, Man., installed 30-ton amalgamating mill at the Rex property, Herb Lake. This is the first gold mill in the district.

Dominion Steel Corporation, Sydney, N. S., installed new coke-oven plant comprising 120 byproduct ovens having 1320 tons' daily output.

Miller Independence Mining Co., Boston Creek, Ont., completed 40-ton mill in October.

Patricia Mine, Boston Creek, Ont., completed 50-ton mill.

Casey Cobalt Mining Co., Ltd., Cobalt, Ont., built new mill.

Mining Corporation of Canada, Cobalt, Ont., installed mining plant at Rickard Township; also increased mill capacity at Cobalt and installed pump for slimes.

Peterson Lake Silver Cobalt Mining Co., Cobalt, Ont., completed 100-ton flotation mill for the treatment of slime and jig tailings.

Provincial Mine, Cobalt, Ont., installed 50-ton flotation plant.

Trethewey Silver-Cobalt Mine, Ltd., Cobalt, Ont., completed 150-ton flotation mill for the treatment of tailings.

The Steel Company of Canada, Hamilton, Ont., completed 80 13-ton Wilputte byproduct coke ovens in December. Plant to have 950 tons' daily capacity.

Burnside Mines, Ltd., Kirkland Lake, Ont., started construction of 30-ton mill, which is expected to be in operation early in 1919.

Kirkland Lake Gold Mining Co., Kirkland Lake, Ont., began construction of a 150-ton mill.

Lake Shore Mines Ltd., Kirkland Lake, Ont., completed new 60-ton mill in March.

Wright-Hargraves Mining Co., Kirkland Lake, Ont., began constructing 150-ton cyanide mill.

Hill Gold Mines, Munro Township, Ont., started installation of a 70-ton mill.

Premier Langmuir Mine, Porcupine, Ont., completed 30-ton mill for the treatment of barite.

International Nickel Co., Port Colborne, Ont., completed refinery in June. Total cost over $5,000,000.

Pittsburgh-Lorrain Syndicate, South Lorrain, Ont., installed small oil-flotation plant.

Davidson Gold Mines Co., South Porcupine, Ont., installed five-stamp mill.

Dome Lake Mining Co., South Porcupine, Ont., installed 60-ton cyanide addition to stamp mill.

Hollinger Consolidated Gold Mines, Ltd., Timmins, Ont., completed new addition to old stamp mill.

Indian Peninsula Mining Co., Cobalt, Ont., began installation of 100-ton Groch flotation unit to treat molybdenum ore at Amos, Quebec.

Mutual Chemical Co., Black Lake, Que., installed 100-ton chrome concentrating mill at the St. Cyr mine.

Bennett-Martin Asbestos Co., Coleraine, Que., built new plant.

British-American Nickel Corporation, Ltd., Nickelton, Ont., continued construction of refinery at Deschenes, near Hull, Que. Estimated cost of plant is $3,000,000.

Eastern Milling Co., Sherbrooke, Que., installed 60-ton concentration and flotation mill at the old Huntington mine.

Platinum

Platinum was one of the metals respecting which there was most concern in 1918, for the supply is diminishing, owing to exhaustion of the placers in the Urals, and there is no known substitute for this metal. In 1917 the market price rose to $105 per oz., owing to the decline of production in the Urals, whence authoritative information to us in the early part of 1917 was to the effect that a price of $100 per oz. was necessary to enable production to be maintained from the poorer ground.

A lot of 21,000 oz. of crude platinum, collected by the Russian-English Bank during 1917, was brought to this country personally by F. W. Draper, and was delivered to the United States Government early in 1918. Had it not been for this supply, our Government would have been ratherly badly off. As it was, the Government found it necessary to commandeer all platinum, which was done in the spring, and the price was wisely fixed at the high level that had already been made in the market, viz. $105 per oz. At the same time the price for palladium was fixed at $135 and for iridium at $175, all the metals of the platinum group being taken over at the same time with platinum. After the signing of the armistice on Nov. 11, the ban on platinum was removed, and on Dec. 1 the platinum market was set free. Trading began then at $105@106 per oz., with strong demand and indications that the price might rise, but that tendency was checked by the news that the Government was offering its surplus platinum for sale at $105.

All of the platinum acquired by the Government was refined at the New York Assay Office, which received upward of 60,000 oz., this including crude platinum, scrap, and platinum sponge. The lot delivered by Mr. Draper, consisting of grains and nuggets, weighed 20,922 oz., from which was refined 17,640 oz. of platinum, 64.751 oz. of palladium, 182.113 oz. of iridium, and 48.563 oz. of rhodium.

No information respecting platinum production in Russia is available. Probably the quantity was very small. However, the high price for the metal is stimulating the production in Colombia, where it exists in the coastal region traversed by certain rivers flowing from the western slopes of the Andes, especially in the Choco district. In that district the British Platinum and Gold Corporation, Ltd., of London, and the South American Gold and Platinum Company (Lewisohn) of New York, are hydraulicking and dredging on a considerable scale. The output of platinum in Colombia was estimated at 12,000 oz. in 1911; 15,000 in 1912; 15,000 in 1913; 17,500 in 1914; 18,000 in 1915; 25,000 in 1916; 35,000, in 1917 and 35,000 in 1918. The Colombian crude yields about 82% of platinum and fetches a price of about £2 10s., or, say, $12.50 below that for refined ingot.

AVERAGE PRICES OF PLATINUM

(In Dollars per Ounce Troy)

	1916			1917	1918
	New York Refined Platinum	Russia, 83% Petrograd	Crude Platinum Ekaterinburg	Metal New York Refined Platinum	New York Refined Platinum
January	90.05	61.25	61.10	87.83	105.9166
February	90.00	61.14	62.625	103.75	107.6818
March	90.75	.....	.....	103.33	108 (nom.)
April	83.10	63.70	63.70	103.77	108 (nom.)
May	80.50	66.64	65.92	105.00	106.2692 (a)
June	78.13	63.70	63.92	104.75	105
July	63.60	63.21	63.92	103.88	105
August	62.56	67.41	66.45	104.55	105
September	84.25	67.41	66.45	104.13	105
October	89.75	77.42	71.44	104.00	105
November	101.25	.....	.....	104.52	105
December	86.87	.....	.....	104.38	105.5400
Year	83.40	.....	.....	102.82	105.9506

New York average for year 1915, $47.13; 1914, $45.14; 1913, $44.88; 1912, $45.55; 1911, $43.12. (a) Fixed May 14 at 105.

At the end of 1918 the quotation for platinum was $105 for refined ingot, while sponge scrap, crude, etc., was bought on the basis of $100 for the fine platinum content. However, a differential of $0.50@1 for sponge and $3 for crude ought to be sufficient.

Alaska's Output of Placer Gold in 1918, according to the U. S. Geological Survey, was about $6,100,000. The Yukon Basin produced $4,325,000; Seward Peninsula, $1,140,000; Copper River, $300,000; Cook Inlet-Susitna region, $215,000; Kuskokwim region, $90,000; and miscellaneous, $30,000. The total production in 1917 was $9,810,000.

Manganese Ore in 1918

A YEAR and a half ago it was generally thought that the manganese situation presented a rather serious aspect. The customary supplies from Brazil and India were, because of the shortage of bottoms, not reaching United States ports, and it was a question as to whether the ever-increasing demands of steel and alloy manufacturers could be supplied from domestic sources. American steel plants had been accustomed to and preferred the use of ferromanganese, and the domestic supplies of ore suitable for making this alloy were believed to be limited. Lack of definite information on this point, and lack of knowledge as to how to use such low-grade ores as were known to exist, were only two of the many factors that combined to make up the great total of America's unpreparedness for entering the war. Committees met and discussed the situation, bills were prepared, studied and reviewed, high prices were promised, and everyone was encouraged to hunt for and mine manganese ore.

What saved the situation, what brought about production, and gave the domestic industry knowledge of domestic manganese resources, was the smelting of lower-grade ores, with competitive bidding and the high prices actually paid.

TABLE I. DOMESTIC PRODUCTION OF MANGANESE ORE
(In Gross Tons)

State	Ore Containing 35% of Manganese or More: Production Jan. 1 to June 30, 1918	Ore Containing 35% of Manganese or More: U.S.G.S. Estimate of Production for 1918	Ore Containing 10 to 35% of Manganese: Production Jan. 1 to June 30, 1918	Ore Containing 10 to 35% of Manganese: U.S.G.S. Estimate of Production for 1918
Alabama	53	600	85	630
Arizona:				
Bisbee district	7,169	13,200	.....	.....
Other districts	2,703	5,572	4,609	6,237
Arkansas:				
Batesville district	4,089	11,000	3,534	8,500
California	10,601	22,158	31	100
Colorado:				
Leadville district	.....	.....	60,804	125,000
Other districts	67	150	.....	.....
Georgia	1,963	5,850	5,151	10,520
Michigan	.....	.....	5,534	22,500
Minnesota:				
Cuyuna district	.....	.....	223,332	625,000
Montana:				
Butte district	28,986	78,500	.....	.....
Phillipsburg district	58,312	133,700	.....	.....
Other districts	40	500	.....	.....
Nevada	12,586	26,870	40,327	85,030
New Jersey	.....	100	.....	.....
New Mexico:				
Silver City district	120	250	6,978	21,050
Other districts	312	500	1,609	1,609
North Carolina	244	250	.....	.....
Oregon	150	500	.....	.....
South Carolina	100	250	850	850
South Dakota	31	31	.....	50
Tennessee	840	3,600	959	2,350
Texas	207	800	.....	.....
Utah	3,701	6,305	.....	.....
Virginia	4,280	13,800	5,206	14,400
Totals	136,554	324,576	314,137	832,866

In the spring of 1918 manganese ore was commanding four to five times the price that it sold for in 1913, and grades were being accepted which could not have been marketed at any price five years earlier. With this incentive, American miners proved equal to the situation, and production of ore, such as it was, increased by leaps and bounds until the middle of October, when information came from Washington that production had reached such a stage that, should importation be entirely suspended, the country could probably fulfil all requirements through domestic supplies. There is reason to believe that there was no intention to create such a situation, as it would certainly have been undesirable. It is now known that the United States has manganese resources assuring the country independence of imports should the necessity arise. At the same time the industry has learned, if the fact was not previously generally known, that there are no manganese deposits in the United States comparable with those of Brazil and India in quality and quantity; that when war demands have ceased, and ample shipping is again available, manganese mining will return to much the same condition as in pre-war days; and that no amount of protection and Government fostering will ever enable American manganese producers to compete with foreign countries as miners of manganese ore.

Production and Consumption

Production statistics given in Table I are condensed from an estimate made by the U. S. Geological Survey. The compilation shows the production of manganese ore in the United States for the year 1918 to have been over 1,150,000 gross tons, containing 10% or more of manganese.

Importations of manganese ores are given in Table II. During the first half of 1918, the principal countries exporting manganese ores to the United States were Brazil, Cuba, and India. Manganese-ore importations in 1918 were about 100,000 tons less than in 1917, but the domestic production was the highest on record. The supply of ore, although often threatened by restriction of imports, was never low. Prospecting was active, and new sources of low-grade ore and the development of new mines were reported almost without limit.

TABLE II. IMPORTS OF MANGANESE ORES INTO THE UNITED STATES, BY COUNTRIES

Countries	Fiscal Year Ending June 30, 1918 (a): Tons	Fiscal Year Ending June 30, 1918 (a): Value	Jan. to June, 1918 (b): Tons
England	2,234	$382,515	.....
Scotland	5	1,217	.....
Canada	832	32,928	.....
Costa Rica	6,017	184,575	.....
Panama	3,676	129,000	.....
Mexico	1,114	32,605	.....
Cuba	67,780	1,479,314	41,984
Argentina	6,600	40,023	.....
Brazil	427,267	9,090,380	171,895
Chile	2,804	44,838	.....
China	20	438	.....
British India	37,150	442,557	22,150
Japan	2,419	79,645	.....
Australia	96	4,300	.....
British South Africa	4	180	.....
Other countries	.....	.....	8,827
Totals	558,018	$11,944,515	244,836

(a) Prepared by Division of Statistics, Bureau of Foreign and Domestic Commerce, Department of Commerce. (b) U. S. Geological Survey.

Perhaps the most notable item in the table of United States production is the position of Montana, which state produced nearly ten times as much high-grade ore as any other state in the Union and more than a third of all produced in the States. Though the Phillipsburg district stands first, as it did in 1917, Butte stands second, and it occupies this position because of the versatility and enterprise of the Anaconda Copper Mining Company.

The presence of the carbonate and silicate of manganese in the Butte silver veins had long been recognized, but the ores had been used only as a flux in furnace operations. Early in 1918 the War Industries Board appealed to Mr. Ryan to stimulate the production of ferromanganese in this country. The outcome of this appeal was that the technical staff developed and

put into practice an electro-thermic process that is a commercial success, producing approximately 100 tons of ferromanganese per day, and of a grade so high that it caused the Washington non-metallurgical authorities no little trouble to see that it was disposed of properly. In fact none of this ferromanganese was marketed.

Nevada occupies second place in the production of high-grade ores, notable quantities having been shipped from the Los Vegas field, from Ely, and from near Golconda.

California has been a fair producer, about thirty operations contributing to the output, but this state labors under the disadvantage of small deposits, widely scattered, and often far from transportation. Fortunately, the power situation in California is such as to encourage smelting by electro-thermic processes, and little of the ore left the state until in the form of ferromanganese.

Virginia, once the premier manganese producing state of the Union, now occupies third place, followed closely by Arizona, which has never before been regarded as an important source of this ore. Arkansas, Utah, Georgia, and Tennessee all contributed important tonnages. Indeed, manganese deposits of workable size have been recognized in nearly every state of the Union, and under a continued stimulus of high prices it is possible that several other states than those mentioned would become important sources of the ore.

Among the producers of low-grade ore, Minnesota stands first, with the production from the Cuyuna Range, and Nevada, Colorado, and New Jersey all produce large quantities of ore suitable for the manufacture of spiegeleisen. Other states are producing in the thousands of tons and are capable of producing much more if the demand for spiegel warrants development and exploitation.

There was considerable experimental investigation of methods for the dressing of low-grade ores by the U. S. Bureau of Mines, but a complete report of the results obtained is yet to be published. Much low-grade ore is now being concentrated to remove silica and other impurities, notably at Phillipsburg, Montana.

About mid-year, the War Industries Board approved a scale of prices for manganese ore, viz: $0.86 to $1.30 per unit of metallic Mn, long ton, f.o.b. cars, South Chicago, Ill., for ores from 35 to 54% and over, respectively, with certain restrictions; standard 48%. The high prices had the effect of greatly stimulating domestic production, and about July 30 the offerings so increased in volume that the market became depressed. Low-grade ore could not be sold, although the high-grade found a ready market at the fixed prices.

The close of 1918 was marked by a continued slump in manganese-ore prices. The market was clearly overstocked, and buyers refused to consider offerings at the established prices.

The Tungsten Industry in 1918

BY GEO. J. YOUNG

THE domestic production of tungsten ores for 1917 is given by *The Mineral Industry* as 5313 tons 60% WO_3; imports for 1917 were 4880 tons; total supply, 10,193 tons. The returns for domestic production in 1918 are too incomplete for any statement, although J. H. Mackenzie estimated the production would be between 4000 and 4500 tons 60% WO_3. The imports for the first semester of 1918 totaled 3487 tons, of a value of $3,558,636. They are given in the accompanying table. Estimated domestic production and imports total 11,500 tons. J. H. Mackenzie gave an estimate of the stocks of tungsten ore, ferrotungsten, tungsten steel, and warehouse stocks of 3878 tons as of May 1, 1918. The estimated tungsten consumption for 1918 is given as equivalent to 11,000 tons 60% WO_3. Under war conditions, the estimated consumption of tungsten in 1919 was expected to be 15,000 tons. Thus tungsten production and available stocks, plus imports, considerably exceeded the 1918 requirements.

Under the stimulus of war necessities there was great activity in the industry in the United States, as well as in other countries, in 1918. The signing of the armistice found large accumulations of stocks of both tungsten concentrates and ferrotungsten, on hand, the effect of which circumstance was to produce a chaotic condition among producers of tungsten ores and manufacturers of tungsten products. Prices fell, the market reflecting the uncertainties which attended inevitable readjustment to a peace basis. The maintenance of a lower price by Great Britain caused export ores, wherever permitted by licensing regulations, to seek the high-price market of the United States. The result was a superabundance of tungsten ore imports in the United States, which caused the condition described by Charles Hardy in his report on the tungsten market, elsewhere in this issue. Before the Committee on Mines and Mining of the U. S. Senate, W. R. Ingalls, on May 10, 1918, made the following statement about tungsten:

> The supply of this metal is probably rather superfluous, production having been greatly stimulated in 1915-16, when the price rose as high as $100 per unit, but before the end of 1916 excess of supply had reduced the market to $16. At present the price is about $20. The supply both from domestic and foreign sources increased from about 1300 tons in 1914 to about 10,000 tons in 1916. The behavior of this market has not indicated that there is any need for encouraging production beyond what natural factors will effect.

The market conditions in the latter part of 1918 amply bore out the foregoing statement that natural factors were the only requirements for stimulating production. At present the market is dormant and the industry in a similar condition.

During 1918 there were three important meetings to consider the tungsten situation. The first was held by representatives of the U. S. Tariff Commission on July 17, in Denver. Colorado producers were present. The result of the hearing was to show that the costs of tungsten production in Colorado were high, and the producers advocated a tariff that would raise the price of domestic tungsten ore to $30@40 per unit on the basis of 60% WO_3 concentrate. The second meeting was held in San Francisco on June 28, and was also before representatives of the U. S. Tariff Commission.

Producers of California and Nevada attended, and advocated stabilizing the tungsten market by a tariff at from $25@40 per unit on the basis of 60% WO_3 concentrate. The third meeting was held in New York on Nov. 25, at which producers, importers, and smelters of tungsten ores discussed conditions generally.

The difficulties attendant upon tungsten mining are those that naturally arise from location, the spotted character of the deposits, the uncertainty of persistence to moderate depths, the relatively high cost of installation, the short life of the deposits, and the marketing of the ores. Small producers are under the necessity of marketing small lots of ores, and as a consequence receive lower prices than the larger producers who market carload lots. Lack of a stable market is the universal complaint of the small producer.

During 1918 there were no revolutionary changes in dressing practice. Closer work of the mills, a greater elimination of impurities, and higher grade of concentrates were features.

It is unfortunate that the buying of tungsten ores in accordance with definite grades and specifications has not been standardized. Changing specifications and uncertainty respecting the marketability of tungsten ores and concentrates have made it difficult for some producers to satisfy themselves that they have received a fair price for their product. Prices are made on the basis of per unit of tungstic acid on the short ton. Scheelite and wolframite are recognized as two important types, although there is little distinction in price of either type where the accompanying impurities do not exceed the following amounts: Sulphur, not over 0.1%; copper, not over 0.02%; tin, not over 0.02%; phosphorus, not over 0.02%. Ores of this type are termed pure or high-grade ores, and where they exceed 60 to 65% WO_3 or over they command the highest prices. The scheelite concentrate and ore of the Atolia mine are in a separate class, and also command a high price. All other ores, whether scheelite, wolframite, or otherwise, are classed as impure ores, and are sold at various prices, depending on the amount and kind of impurity as well as upon the facilities of the buyer for the treatment of the different kinds of ore.

That the limits given are not universally recognized is shown by Charles Hardy's classification, which places the maximum percentage of impurity for high-grade ore and concentrate at tin, 0.05%; copper, 0.05%; and phosphorus, 0.04%. All ores and concentrates exceeding these amounts of impurity are called off-grade ores. Other firms have specifications which make no use of the terms high-grade, off-grade, or impure, but merely specify the lower limit of tungstic acid and the upper limit of certain impurities. The highest-grade wolframite marketed contains 70% tungstic acid, traces of tin and copper, and manganese under 1%. Tungstic acid content ranges from 10 to 72%, although there is recognized, to some extent at least, a base grade containing 65% tungstic acid. In some cases a 60% grade is named. There is no recognized deduction or addition in price for a variation in tungstic acid content in either direction from the base grade. Ores with impurities may contain the following range: Sulphur, up to 3 or 4%; tin, up to 10%; copper, up to 3%; phosphorus, up to 0.3%. Certain foreign ores even exceed these percentages, as the tungstic acid content may reach 45%, copper 6%, and tin, 19%. Some buyers handle only scheelite, others wolframite, and still others both types. There is need for a clean-cut classification.

COLORADO

The tungsten production of Colorado in 1918 is estimated at 1500 tons of 60% WO_3 content, as against 2200 tons in 1917. Boulder County produced about 90% of this, the remainder coming from Gilpin County, with small percentages from Lake, Park, San Juan, Eagle, and Chaffee counties. The crude ores, as mined, range from 0.7 to 20% WO_3. Some mills treat only high-grade ores; others ores better than 12% WO_3, but most of the plants are operating on low-grade ores of variable quality.

Some of the active producing companies are the Wolf Tongue Mining Co., at Nederland; the Vasco Mining Co., at Tungsten; the Primos Chemical Co., at Lakewood; the Rare Metals Co., at Rollinsville; the Black Metal Production Co., at Boulder; the Tungsten Products Co., in Boulder Canyon; and the Red Sign Mill, at Ferberite.

Many conditions have operated to retard production, the most important of which was the lack of a stable market and competition with imported ores. The cost of tungsten ore production in Colorado ranges from $15 to $33 per unit. With few exceptions, mills have been running below their capacities. This is thought by some operators to be due to the pinching out of the veins in depth. However, some mines report improvement at depth. Falling off in production is ascribed by others as attributable to hard conditions in leases and settlements imposed by large operators and buyers.

Milling has reached a high state of development. No success has attended the attempts to use flotation. Some new properties were opened in 1918, but the operations have not been profitable. Other discoveries have been made but not opened up. Tungsten mining on new properties is at a standstill.

CALIFORNIA

The tungsten production of California for 1917 was, according to the report of the California State Mining Bureau, 2466 tons 60% WO_3 concentrates, of a total value of $3,079,013. The principal production was from San Bernardino County, which produced 1943 tons; Inyo and Nevada counties, 474 tons, and Kern County, 49 tons. The principal producer is the Atolia Mining Co. There was more or less activity at Bishop, Inyo County, at which place the Tungsten Mines Co. is operating. Though production figures for 1918 are not available, the production for the year will probably exceed that of 1917.

NEVADA

The principal activity centered at Tungsten, near Mill City, and at Toulon, 18 miles west of Lovelocks. In the latter part of 1918 two mills at these points were approaching completion, one of 100 tons and the other of 125 tons' daily capacity. The two companies erecting the mills are the Nevada Tungsten Co. and the Mill City Tungsten Co. In the vicinity of Sodaville there was some activity, and, late in 1918, two addi-

tional mills were reported about to be erected. New discoveries were reported in the vicinity of Rebel Creek, Humboldt County. Operators were reluctant to report outputs, and, as a consequence, the production of Nevada for the year cannot be given.

Foreign Tungsten Producers

Reports of foreign tungsten production are unavailable for 1918, but fairly complete statistics are given by *The Mineral Industry* for 1917. According to these, Burma, Portugal, China, Australia and New Zealand, Argentina, Bolivia, Chile, Peru, and Japan each made production in excess of 1000 tons per annum. Mexico, England, Spain, Siam, the Federated Malay States, and Rhodesia made substantial production. The production of tungsten ores in Portugal was described by F. W. Foote and R. S. Ransom, Jr., in the *Journal* of July 13, 1918.

The world production in 1917 was about 20,000 tons, divided into somewhat over 5000 tons for the United States and 15,000 tons for all other countries. It is evident from these figures that there is much potential production, however scattered. The outstanding fact is that tungsten deposits, although relatively superficial and small in quantity, are numerous and occur in many localities. If the discoveries made in the last five years are any indication of the future, there is promise of sufficient number of new discoveries to maintain output. Necessarily, the small size of the deposits and the great distance that separates most of them from the few marketing centers will make toward high costs, and relatively high prices must rule if returns from the mining of tungsten are to be sufficiently attractive to keep up the interest of those engaged in the industry. The actual production being large, and the potential production susceptible of considerable increase, there is need for an increased consumption. Up to the present the greatest use for tungsten has been for the manufacture of high-speed steels. There is a growing tendency to employ tungsten steel in machine parts and miscellaneous small uses. If these uses can be extended and new ones discovered, there is promise of sufficient increased consumption to absorb any probable increase in production.

TUNGSTEN ORE IMPORTS FOR SIX MONTHS ENDED JUNE 30, 1918(a)

Country:	Tons	Value	Country:	Tons	Value
France	26	$3,400	Chile	612	$636,719
Portugal	24	17,760	Ecuador	5	9,797
Canada	11	36,000	Peru	1028	863,947
Costa Rica	16	19,081	China	615	608,533
Panama	21	23,109	Br. East Ind.	17	13,071
Mexico	178	154,514	Hongkong	213	193,422
Argentina	203	309,312	Japan	483	623,706
Bolivia	25	37,500	Siam	10	8,583
Total				3487	$3,558,636

(a)U. S. Department of Commerce.

Total imports for 10 months ended Oct. 31, 1918, were 7001 tons, valued at $7,536,875, as against 4373 tons, valued at $3,594,961, for the corresponding period of 1917.

Tungsten Ore Market

By CHARLES HARDY*

THE tungsten ore market started in 1918 with a considerable accumulation of off-grade ore in New York, and also a fair quantity of high-grade material, urgently needed by the trade, but not salable, because traffic conditions made the transfer of ores from New York to the mills exceedingly difficult. Prices ranged from $24.50 to $25 per unit for scheelite, as well as for wolframite, and they did not fluctuate during the year to any appreciable extent.

The congestion on the railroads operated in favor of the stocks in New York in January and February, and western ore traveled, at times, two and three months before it reached its destination; and buyers, running short of material, preferred to buy spot New York delivery, which, though delayed in delivery, reached the works quicker than material sent from California and Nevada. During February the American Iron and Steel Institute introduced a licensing system which covered the molybdenum, vanadium, manganese, chrome, and ferro alloys from abroad, and hence the importations of these minerals were under strict control. The March market was dull, but, during April, the business became much livelier, and though importations gradually increased, and amounted during the first two months to more than 1000 tons, considerable business was possible, and prices were fully maintained around $24 and $25 for wolframite and scheelite, respectively.

In May, China, which had accumulated a considerable amount of tungsten ore, started to compete actively for orders in this market, as Great Britain allowed exportations from Hong Kong, and the importation of this Chinese ore effected a great change on the American market for the rest of the year. It was not at first realized that the quantities from China might be large. The accumulation of 500 tons, which was spoken of, was assumed to be the accumulation of many months, as during 1917 the total exportation from China to this country amounted to less than 200 tons. The Chinese ore, although high in tungsten content, showed a large percentage of manganese, and, almost invariably, an appreciable percentage of tin. Tin, though it can be utilized abroad, is, to most of our users of tungsten ore, of the greatest detriment; and the importations from China soon reached such a point that the shipments could not be absorbed by the existing tungsten-ore reducers, and stocks began to accumulate.

AVERAGE MONTHLY PRICE OF TUNGSTEN ORE (a)

(In Dollars per Unit, WO_3)

	1917			1917	
	Wolframite	Scheelite		Wolframite	Scheelite
January	17.14	17.50	August	24.66	26.50
February	16.80	17.50	September	23.92	26.00
March	17.17	17.77	October	24.00	26.00
April	17.86	19.04	November	26.00	26.00
May	19.10	20.94	December	25.24	26.56
June	20.80	23.50			
July	23.44	25.68	Year	21.34	22.75

	1918			1918	
	Wolframite	Scheelite		Wolframite	Scheelite
January	24.75	26.00	August	24.50	25.05
February	24.50	26.00	September	24.50	25.35
March	24.00	24.55	October	25.00	26.00
April	24.00	24.50	November	(b)	(b)
May	24.00	24.13	December	(b)	(b)
June	24.00	24.00			
July	24.00	24.00	Year	24.325	24.958

(a) *Engineering and Mining Journal* quotations. (b) No market.

*Ore broker, 50 Church St., New York.

High-grade tungsten ore continued to sell, right down to the signing of the armistice, at prices of $24 and $24.50 for wolframite, and $25 and $26 for scheelite, and off-grade ore, which could be used in only a few quarters, dropped in price and showed a margin of from $5 to $6 per unit below the price of high-grade ore.

During July and August, the United States Government was of the opinion that the war would last well into 1919. The available supply of tungsten ore in this country would, therefore, not be sufficient to meet the anticipated increased consumption, and the Government actually entered the market as a buyer, to obtain available stocks. In turn it induced the consumers to lay in stocks to cover their requirements for several months ahead. Purchases made at this time were all of high-grade material as a rule, and the stocks of off-grade tungsten became larger and larger. In addition, the Chinese production increased beyond all expectations. Though total shipments to this country, as heretofore stated, amounted to less than 200 tons in 1917, the receipts during the first six months of 1918 increased to about 400 tons monthly; and during the months of July, August, September, and October actually reached the figure of 1200 tons per month.

In view of the fact that the price for tungsten ore in the United States was higher than that quoted by any of the European buyers, the bulk of the Chinese shipments were directed to this country; and if at the moment of writing the tungsten situation is very obscure, it is entirely due to this unexpected influx of Chinese ore into the United States.

This can be better understood when it is considered that the total importations from all countries into the United States during 1917 amounted to only just over 4000 tons, and that the importations from China, a new source altogether, alone exceed this figure. The estimated consumption of tungsten ore during 1918 was 11,000 tons. I believe this figure is nearly correct and that this amount was fully consumed.

For 1919, the estimated consumption under war conditions was 15,000 tons. The Government, therefore, relying upon the usual production here and the normal importation, anticipated a rise of the market, and hence purchased heavily. When the war came suddenly to an end, the market prices were still at $24 to $25 for high-grade wolframite, and $25 to $26 for high-grade scheelite, practically showing the same values as existed at the beginning of the year. The only change that occurred was the difference in off-grade ore, which, instead of selling at $1 per unit under the high-grade price, sold at $6 per unit below. This big margin acted as an incentive to some of the works to buy this low-grade ore and mix it with high-grade ore, or actually to start to build additions to their plants for the treatment of Chinese and off-grade ore by the acid process. A margin of $6 per unit, or $360 per ton, is sufficient to warrant manipulation of ores to a considerable extent.

When the armistice was signed, Nov. 11, the business in tungsten ore came almost to a complete stop. Those who had contracts with the Government and others for ferrotungsten and tungsten steel found that a considerable number of orders were canceled; and, whereas new business for peace purposes was booked, this did not even counterbalance the full quantity canceled. Thus the operators find themselves with a small volume of business, and are exceedingly reluctant to commit themselves for new purchases of ores unless an equivalent amount of finished material is sold at the same time. In consequence of this condition, as well as the receipt of imports, ore stocks have materially increased.

It looks as if the tungsten industry will be hard hit through the readjustment of prices, and at the moment of writing the entire industry—that is, the producers in the West, the importers, the ferrotungsten maker and the steel maker—has combined and is laying its case before the authorities in Washington. What the trade wants is not compensation from the Government, but assistance to allow the war situation in the tungsten market to be liquidated in an orderly rather than in a panicky fashion. This article may be published before the result of the efforts in Washington is known, and, therefore, it is exceedingly difficult to make any forecast as to the prospects of a reopening of the market at an early date, or concerning the price which will govern the first sales.

Chrome Ore in 1918

BY F. F. SHARPLESS

THE condition of the chrome ore business, from the miner's point of view, in 1918, is well paraphrased by the familiar quotation "Off ag'in, on ag'in, gone ag'in," which, in a nutshell, describes what has happened to the producers' market within the last twelve-month period.

The accompanying table from *Mineral Resources*, 1917, read in conjunction with press reports widely circulated during the latter part of 1917 and the early part of 1918, partly accounts for the marked increase in the domestic production during 1918.

With a normal consumption during the pre-war years of 66,500 tons metallurgical, coincident with increased production of munitions, the United States began calling for additional supplies of ferrochrome alloys, which demanded, in their turn, additional supplies of high-grade chrome ore. There was no misrepresentation in the fact that a very large amount was needed for arms and armament, and for military supplies outside of these two items. For these purposes there was no substitute immediately available, and it was a fact, as shown by the table, that importations were growing less, owing to lack of transportation. Under these conditions it is not

AVAILABLE SUPPLIES OF CHROMITE, 1913-1917

Year	Domestic Production, Long Tons	Imports, Long Tons	Quantity Available, Long Tons
1913	255	65,180	65,435
1914	591	74,686	75,277
1915	3,281	76,455	79,736
1916	47,035	115,945	162,980
1917	43,725	72,063	115,788
1918	.....	88,531(a)	.....

(a) Imports for 10 months ended Oct. 31, 1918, by U. S. Department of Commerce.

surprising that users of the metal gave wide publicity to their requirements, and were supported by the Government in urging a maximum production at home by every one who knew where the ore existed. This production was urged both through appeals to patriotism and through rapidly rising prices.

The price of 40% chromite at the beginning of 1917 was about 37½c. per unit. By the end of the year it had advanced to 70c., and on June 1, 1918, it was quoted at $1.20 per unit. No limit was placed on the probable consumption, and the general impression was permitted to go forth that all possible production could be taken at this or better prices during 1918 and for such time as the war might continue.

The Pacific Coast responded quickly to these high prices, and by July 1 gave promise of supplying a large portion of the deficiency. With the cessation of hostilities the market for ore practically disappeared, and no reliable data are available as to the quantity and quality of ore that has been mined or could have been put upon the market had demand continued. One thing is certain: at the time demand ceased production had not attained its maximum.

War Resulted in Abnormal Markets

The mining of chrome ore in the United States must be regarded largely as a war measure and one that must sensibly diminish or return to the previous condition with the resumption of normal trade. No large bodies of ore, capable of being mined cheaply, have been discovered in the United States as a result of recent activity. On the other hand, reports from Brazil indicate the recent development in that country of several large bodies of high-grade ore, and a like condition also exists in Rhodesia, which was shipping 50,000 tons per annum before the war. Domestic producers of chrome ore cannot compete with these and other foreign sources without a tariff so high that it would simply mean that American steel manufacturers could not pay the requisite prices.

There were perhaps 350 producers or operators preparing to put chrome ore on the Pacific Coast market when the armistice was signed. Many of them have lost much or all that they have put into development, and are now asking the Government to let them get out without loss. Many of these operators deserve sympathy, but, under existing conditions, can scarcely expect special legislation.

Though the authorities in Washington admit that every effort was made to stimulate production to the maximum, and in this acknowledge, to a certain extent, moral responsibility toward the prospector and small producer, the operators must realize that Albert Burch and Samuel H. Dolbear, who gave special attention to this subject on behalf of the Government, fully warned them that the high prices would only continue during the war. And, further, what may be more to the point, these two officials gave some excellent advice upon the financial side of the development and equipment of chrome prospects, which, if it had been followed, would have resulted in so small a loss, regardless of the cessation of hostilities, that the losers could have readily charged this amount to their share in the cost of winning the war.

Molybdenum Ores in 1918

Previous to 1914, little was known of the properties of molybdenum alloys, and they had been used to only slight extent. With the coming of the war, and the increased use of tungsten, the price of that metal rose to a point that made the search for a substitute attractive. Molybdenum was known to possess some similar properties to tungsten, and search for deposits of its chief ore, molybdenite, was extended all over the world.

Molybdenite may be called a common mineral, as it is found in many places, but in few where it is sufficiently concentrated to form an ore of commercial importance. The development of molybdenite deposits has been retarded through the fact that manufacturers, unable to assure themselves of a constant supply at a reasonable cost, have hesitated to conduct costly experiments for the purpose of studying its properties and placing its alloys on the market, and, not knowing its properties and the extent to which it might be used, they have been unwilling to contract for any appreciable tonnage. On the other hand, miners with molybdenum prospects, being unable to get any bids for their product, have been slow to develop and prepare their properties for production; hence the dormant condition of the industry.

In the autumn of 1915 the British government fixed a price of $1.09 per lb. of MoS_2 contained in 85% concentrates, at Ottawa, the price varying up and down with the percentage of MoS_2. At the same time there was a small nominal market in the States for the sulphide, at about double this price. The assurance of a market for all that could be produced in Canada stimulated search for the metal, even at the lower price, and resulted in the opening of a large number of small deposits in Quebec and Ontario. In 1917, with definite information that the metal was being used by the ordnance departments of the French and British governments, and with a small demand at $2 per unit in the States, prospecting and development became more active on this side of the line, culminating in the opening of large deposits at Climax, Summit County, Colorado.

At Climax the molybdenite is rather uniformly disseminated through a silicified zone of alaskite-granite, variously estimated to contain an average of 0.6% to 1% MoS_2. After the expenditure of nearly $600,000 in development and the construction of a mining and milling plant, the American Metal Co., owner of the largest developed deposit at Climax, is now milling about 250 tons per day, with the recovery of about 11 lb. of MoS_2 per ton of ore treated. The concentrates contain 65% or more of molybdenite. The Molybdenum Products Co., working at the same place, has not made public information respecting its operations. It is reported that this property is now more or less under the control of the American Metal Company.

With the cessation of hostilities it is probable that those who have been studying the properties of the metal and its alloys, particularly in the manufacture of ordnance supplies, will make public information which they have felt should be kept as secret as possible. We know that it has been used in the manufacture of guns, gun carriages, motors, and automobiles. It is used in the place of tungsten for certain heavy cutting tools. Molybdenum is also used in the form of an alloy with

chromium, cobalt, and tungsten in the manufacture of high-grade small tools for surgery and dental purposes. This alloy retains an edge equal to the best steel, does not rust, and is not attacked by acid or alkaline antiseptic solutions.

The future of molybdenite mining is extremely uncertain, depending almost entirely upon the development of uses for the metal in the manufacture of alloys. If it is found that it can be used to considerable extent with advantage, the metal can be produced. The outlook for the small deposits of high-grade ore, workable when the sulphide sold for $1 to $2 per lb., is not promising. From the large deposits of Colorado the sulphide can probably be produced at a cost of less than 50c. per lb., and the available tonnage of this locality exceeds any probable demand for some years to come.

The concentration of molybdenite has been one of the most difficult problems in ore dressing, mainly because of the peculiarities of MoS_2, and subordinately because of the high-grade concentrates demanded by the ferromolybdenum makers. Considerable progress, nevertheless, has been made in milling practice. The mill of the Climax Molybdenum Co. at Climax, Colo., is designed to have a maximum capacity of 400 tons per 24 hours. It contains two ball mills, Callow and Janney flotation machines, Goldfield agitating tanks, a drum filter and a steam driver. The crusher plant is situated near the mine outlet.

Molybdenum Ore Market

BY CHARLES HARDY*

To those interested in the production of molybdenite, 1918 was a most unsatisfactory year. The market started strong during the early days of January, with a price quoted at $2.25 to $2.30 per lb. for the 90% molybdenite concentrate.

During the months of January and February a fairly large business was done, and the quantities that were available in warehouses at the beginning of the year were fully absorbed by the end of February. A considerable amount of the ferromolybdenum sold in this country was for account of European buyers, and a large amount of ferromolybdenum found its way to Russia. With the collapse of Russia as a belligerent, and therefore as a buyer of war material, the orders placed either by Russia directly or through English and French sources were stopped or canceled, and the molybdenum which was thus released absolutely swamped the market. A little molybdenum went into the motor industry, but not enough to absorb the molybdenite which was offered, and though molybdenite was placed on the restricted list, and all further imports were forbidden, the quantities available in this country, either at the mine or in warehouses in New York or Pittsburgh, remained unsalable. Most of the mines producing molybdenite shut down, and only the largest producers have kept in operation.

During the latter part of 1918, I understand that molybdenite was more favored by some of the steel plants and a little business was done, which kept the larger producers going, but left the stocks of molybdenite in Pittsburgh and New York, and the accumulated material at the mines, untouched. Only at the end of 1918 was the bulk of molybdenite in Pittsburgh and New York taken up by buyers, but to ship this material it was necessary to reduce the price to 85c., or practically to 40% of the price which ruled at the beginning of the year.

AVERAGE MONTHLY PRICES OF MOLYBDENITE (*a*)

(In Dollars per Pound in Concentrates Assaying 90%)

	1917		1917
January	1.81	July	2.16
February	1.80	August	2.14
March	1.90	September	2.18
April	2.10	October	2.20
May	2.95	November	2.20
June	2.15	December	2.27
Year			2.16

	1918		1918
January	2.233	July	1.134
February	2.150	August	1.000 (*b*)
March	1.901	September	1.106
April	1.800 (*b*)	October	1.000 (*c*)
May	1.250 (*b*)	November	0.875 (*d*)
June	1.250 (*b*)	December	0.850 (*d*)

(*a*) *Engineering and Mining Journal* quotations.

(*b*) Nominal. (*c*) Estimated—no market. (*d*) No regular market. A few sales reported at 87½ @ 85c.

The future of the molybdenite market is by no means assured. The production of the world, which amounted to less than 250 tons in 1915, has now been quadrupled and quintupled; yet the use of molybdenum in place of tungsten in tool steel and high speed steel has not been found entirely practicable. Its main uses during 1918 were for gun linings, armor plates, projectiles, and to a limited amount in the motor industry. Whether sufficient peace purposes will be found to keep molybdenite even at its present price remains to be seen.

Ferro-Alloys in 1918

BY ROBERT J. ANDERSON†

THE developments of 1918 centered the world's ferro-alloy industry in the United States, and this country now leads in the production of all kinds of ferro-alloys. The need of the special steels for numerous industrial and military purposes is so vital that the ferro-alloys entering into their manufacture must be esteemed a valuable aid in the successful prosecution of the war. Although the armistice has been signed, and peace will, in due course, be a matter of fact rather than of fancy, it is not to be expected that prewar conditions in the ferro-alloy industry will be attained in any brief period of time. Both future prices and demand are somewhat in doubt at the moment of writing, but the expected large domestic steel requirements should reflect favorably to the ferro-alloy producers.

Although the stimulation brought to the industry by the war was an incentive to enlarged development, the progress made lately would have been impossible without the electric furnace, as the production of the

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various ferro-alloys, with the exception of ferromanganese, is not possible on a large scale without the electric furnace. Railroad congestion in the early months of 1918 prevented shipments, with the result that all alloys for prompt delivery were scarce then, and the markets were firm. The sudden termination of the war was reflected marketwise at the close of the year.

Technical advances in metallurgical processes were noteworthy in one or two instances. In the literature, Robert M. Keeney's paper[1] before the American Institute of Mining Engineers, at Denver, was an excellent contribution. In short, it is no exaggeration to say that the year just brought to a close bordered on the marvelous when all aspects are considered broadly.

Ferromanganese

Ferromanganese imports in 1918 dropped about 10,000 tons from the 1917 figure, but both production and exports were larger than in the preceding year. There was at times anxiety as to supplies of 70-80% alloy, but this had no foundation. As a matter of fact, the available supply in March was about 331,000 tons, or more than enough to make 44,000,000 tons of steel. A departure in standards for the commercial iron-manganese alloys was witnessed: The 80% alloy was lowered to 70%, and 16-18% was adopted for spiegeleisen. Though the change in standards met general acceptance by the trade, a virtual increase of $40 a ton resulted for ferromanganese, and a differential of $4 was adopted for ferromanganese over 70 per cent.

An interesting metallurgical development is the use of the electric furnace for ferromanganese manufacture. Whether this alloy will be made in large tonnages in the electric furnace when normal conditions return, is in doubt; however, this constitutes one of the most important advances which have occurred. As 1918 closes, about 15% of the total ferromanganese made in the United States is the product of the electric furnace. The Anaconda Copper Mining Co. produced electric-furnace ferromanganese late in 1918, and the estimated output is 30,000 tons a year when in complete operation[2]. Domestic ferromanganese sold at $250 a ton in 1918. Spiegeleisen was quoted at $70@75. English ferromanganese sold at $325.

Ferrosilicon

The present domestic capacity for production of 50% ferrosilicon is around 100,000 tons a year, or an expansion of 100% since the war started. Prior to the war, and even up to 1916, there was only one large producer in this country, viz. the Electro Metallurgical Co., Niagara Falls, N. Y. There are now four new large producers and several small ones. The United States Steel Corporation, in 1918, began the manufacture of 75% ferrosilicon, at the Duquesne plant of the Carnegie Steel Co., Pittsburgh, Penn. The output is to be absorbed by the corporation in the manufacture of high-silicon steel for electrical purposes. Insufficient market supply of the 75% alloy is given as the principal reason for the installation. Ferrosilicon had not been made heretofore by this company.

For the large demand for ferrosilicon, the greatly augmented output of shell steel is responsible to considerable extent. Shell steel requires a higher than usual silicon content. New and interesting uses have been found for ferrosilicon. For example, the 80-90% grade has been used in Canada in the preparation of hydrogen for military balloons, the alloy being used to decompose caustic soda or steam, the reaction giving hydrogen. Another important advance in the ferro-alloy industry has been the electric-furnace manufacture of low-grade 10-15% ferrosilicon. This is a departure, and the product has been in strong demand as a substitute for regular bessemer ferrosilicon. The latter commanded high prices in 1918, viz. $54 to $61.60 for from 9 to 12% grades, respectively, and the electric-furnace product was readily disposed of. Practically all the larger users of 50% ferrosilicon were covered on contract for all of 1918, and at lower prices, in general, than were paid in 1917. Although ferrosilicon is normally produced where electric power is cheap, under the conditions engendered by the war the alloy has been made profitably even where electric power is costly, as, for example, at Baltimore, Md., and at Anniston, Ala. New plant additions were made both in the United States and Canada. Raw materials were readily available. The 50% grade sold at $160@175, delivered, Pittsburgh, in the early part of 1918, and the price was maintained around $180@190 during the remainder. Contract prices varied, $100@175.

Ferrochromium

In 1918, most of the ferrochromium used in the steel industry went into chromium-nickel and chromium-vanadium steels, either directly or indirectly, to satisfy Government requirements; and, in reality, all chromium was specifically conserved for Government purposes. Both the ferrochromium and chrome-ore situations were well in hand at all times, but the steel makers were behind on production of chromium-containing steels. Despite labor and transportation difficulties in the first half of the year, the domestic output of chrome ores was the highest on record. Much ore came in from Rhodesia and New Caledonia, notwithstanding the scarcity of ships, and Canada and Mexico shipped some ore by rail. In the United States, Oregon and California were the principal producers. Washington and North Carolina entered the list of producing states, and Alaska made some shipments. In Asia, the Turks continued to hinder the development of the enormous deposits of high-grade ore near Broussa, and these important deposits have not figured in the markets.

Ferrotungsten

A commanding lead is now held by the United States not only in the production but also in the consumption of ferrotungsten. In 1914, Germany was the leader, but its supremacy has passed, doubtless never to return. The greatly increased demand for high-speed tool steel for machining shells stimulated the production of both ore and alloy. The world's largest producing district for scheelite is the Atolia district in the Mojave desert; the other large ore district in the United States is that in Boulder County, Colo., and mines in Arizona are also important. The extent and persistency of the deposits in California and Colorado have been thoroughly demonstrated, and the output of ores from these states largely

[1]Bull. A. I. M. E. No. 140, p. 1321.

[2]Although a metallurgical success, the high-grade ferromanganese produced at Butte did not fulfill the requirements of the War Industries Board, in consequence of which none of the product has been sold, and the plant is idle.

supports the domestic ferrotungsten industry. Portugal is still the chief European producer, and though Burma's output is large, no figures are available to permit comparison with the United States. Fair progress in mining and milling has been made lately in Australia, and the milling of tungsten ores in the Colorado district, on ores not containing non-metallic impurities, has attained the highest development reached anywhere. No success has yet been attained in tapping high-grade ferrotungsten direct from the furnace. Ferrotungsten sold at $2.25@2.40 per lb. of contained W throughout all of 1918.

FERROMOLYBDENUM

Prior to 1914, less than ten tons of ferromolybdenum was made per year in the United States. In 1918, several hundred tons was produced, mainly for export. The alloy has not been used much by domestic steel makers, because of a presumed scarcity of ore and also because of prejudice. As a matter of fact, there has never been a scarcity of ore deposits, but there was no reason for developing existing deposits and attempting to market a product for which no demand was apparent. The use of molybdenum in steel is comparatively recent, and it is also so intimately connected with military matters, both overseas and here, that little can be made public.

Though the increased demand for molybdenum since the start of the war created an unusual interest in the metal, it has not been used much in the United States. The ferro-alloy has been used principally by European governments for additions to steel for military purposes —for steel for trench helmets, gun linings, and armor-piercing projectiles. The standard grade of ferromolybdenum is not well established. Alloys are offered with 50 to 80% Mo and 1 to 3% C. Ferromolybdenum sold at $5 per lb. of contained Mo from January to August, 1918; dropped to $4@4.50, and closed at $3.50@4.50.

FERROVANADIUM

The pioneer work in vanadium metallurgy was done in the United States, and this country is today the largest producer of ferrovanadium in the world. Ferrovanadium exports were the largest on record, and the alloy was in heavy demand for both domestic use and foreign shipment. The most important sources of ore are, as previously, the Peruvian patronite deposits and the carnotite and roscoelite deposits in Colorado and Utah. The entire Peruvian output goes to the United States for reduction. The market on ores in 1918 was poorly defined. About 75% of the ferrovanadium produced in the United States is made in the openhearth or crucible furnace by a modification of the thermit process, but the use of the electric furnace for its manufacture has increased lately. The electric-furnace ferrovanadium is made with 90% silicon as the reducing agent. Prices for the alloy in 1918 varied from $3.50 to $5, f.o.b. works.

FERROTITANIUM

In ferrotitanium, the standing of this country is preeminent. The principal producers are the Titanium Alloys Manufacturing Co., Niagara Falls, N. Y., and the Metal and Thermit Corporation, New York, N. Y. Both kinds of alloy continue to be extensively employed in the steel industry as deoxidizers, particularly for rail and sheet steel, but their use has extended to all kinds of plain steel made. There is an abundance of ore, both rutile and titaniferous-iron ore. The largest deposits of the former are in the Roseland district, Nelson County, Va., and the largest domestic deposits or titaniferous-iron ores are at Lake Sanford, N. Y., and at Iron Mountain, Wyo. Ferrocarbon titanium sold at $160 per ton, f.o.b. Niagara Falls, N. Y., for the 15-18% grade, carloads, in the first quarter of 1918; round advances to $200 went into effect in April, and the closing price was $200@250, depending on the size of purchase. Ferrotitanium was higher in price.

FERRO-URANIUM

Originally, ferro-uranium was developed for the purpose of utilizing the large amounts of sodium uranate, $Na_2U_2O_7$, which accumulated as a byproduct of radium manufacture, and not because of any particular demand. The alloy is made from sodium uranate and from uranium oxide, U_3O_8, in the electric furnace. The claim has been made that 0.5% U will replace several per cent. W in tool steel, and consequently the price of ferro-uranium is high. So much contradictory information is current, that it has been difficult to ascertain the facts to date. However, the alloy is finding further use in the steel industry for making ternary-uranium and quaternary-uranium-tungsten steels. The high price has acted as a deterrent to wider experimentation. Uranium oxide brought $3.25@3.60 per lb. in 1918, and uranium ore (carnotite) sold at $3 per lb. of U_3O_8 contained, for 2% minimum. Ferro-uranium was quoted at $7@7.50 per lb. of contained uranium.

FERROZIRCONIUM

The possibility that zirconium may assume an important position as an additive element to steel has become fairly well recognized. The most important industrial ores of zirconium continue to come from Brazil from the deposits in the states of Minas Geraes and Sao Paulo. No production of zirconium ore has been reported in the United States for several years, although some formerly came from North Carolina. The Brazilian mining is very crude. Metallurgical ore sold at $100 to $140 for 80% ZrO_2, minimum. Ferrozirconium is made by the reduction of zirconia with aluminum by the thermit process, and is produced so as to contain upward of 3% Zr. In England, a 20% ferrozirconium has been used to a subordinate extent in place of ferrotitanium in scavenging steel. The zirconium-bearing steels are reported to be adapted for bullet-proof sheets, armor plate, and armor-piercing projectiles. Both ferrozirconium and ferrochromium zirconium were made in small lots in the United States in 1918.

MINOR FERRO-ALLOYS

Ferro-aluminum is not now being made, as it has been replaced by impure aluminum ingot in practically all steel works. Its electric-furnace production is a possibility, however, as a 50% ferro-aluminum might be made from ferruginous bauxite. The iron-bearing bauxites constitute an almost inexhaustible source for the manufacture of such an alloy. Ferroboron has not yet been manufactured on a commercial scale, but small quantities have been made, for experimental purposes, in the electric furnace. An enlargement of the domestic ferrophosphorus output is in prospect in the South in

connection with the phosphate industry. In pyrophoric alloys, viz. ferrocerium, the New Process Metals Co. has vigorously developed the business in the last two years. Production is now several thousand pounds a month, and the domestic output supplies all the sparking alloy for use in igniters for mine lamps, lanterns, automatic cigar lighters, and other uses. This alloy has also found considerable application in hand grenades and in projectiles. Ferrocerium sold at from $15 to $30 per lb. in 1918. No noteworthy developments occurred in the complex ferro-alloys.

Metallurgy of Quicksilver

By Murray Innes*

The most interesting development in the metallurgy of quicksilver during the year 1918 was the pronounced success of the rotary furnace of the cement kiln type, as introduced at the New Idria mine by H. W. Gould. The first furnace of this type was installed early in the year, and has been in operation about nine months, during which time I am informed it has produced upward of 1500 flasks of quicksilver. Two others have recently been put in operation, and two more are in course of construction. This type of furnace has also been adopted at the Cloverdale and the Rutherford mine, which latter property is also under the Idria management, and there is no apparent reason why it should not be a metallurgical success at these properties.

During 1918 the U. S. Bureau of Mines, under the able direction in California of Dr. L. H. Dushack, continued research work in connection with the metallurgy of quicksilver, and will doubtless publish in the near future a résumé of its operations and conclusions, which should be of great interest to quicksilver operators.

For condensation purposes, Dr. Dushack is inclined to favor, I believe, a more extensive use of tile pipe to replace largely the brick and wooden condensers heretofore in use in connection with the Scott furnace, and I am inclined to believe that this is a decided advance, both in the matter of first cost and in simplicity of operation.

In comparing the cement kiln type of rotary furnace with the Scott type of shelf furnace, one has to consider both the installation and the operating costs, and I think that, with the exception of large mines like the New Idria, where dependable power and skilled labor are readily available, the Scott type of furnace is the most desirable.

In the matter of first cost one must separately consider the furnace and the condenser system, and if the furnace alone is considered there seems little choice under present conditions. In the matter of operating costs, the Scott furnace seems to have an advantage, for the reason that no skilled labor and no power are required, and also because it may be operated with either wood or oil fuel, whereas the rotary has not proved a success except with oil fuel, which is not always available in out-of-the-way places. Judging by results at the Chisos mine, in Texas, and at the Sulphur Bank, in Lake County, Calif., the rotary furnace has not proved satisfactory on ores containing large amount of sulphur nor on ores containing an excessive amount of fines.

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The rotary furnace has an advantage in that it will handle wet or damp ores directly without the use of a drier, whereas the Scott furnace does not give perfect satisfaction except when a drier is used. This latter problem has been fairly well solved at the Oat Hill mine, where a small shelf drier containing about ten tons of ore has been superimposed upon a 40-ton Scott furnace, utilizing the waste heat from the burned ore. This drier has so far given perfect satisfaction, and seems to solve the problem at this property.

I am informed that the rotary plant of five furnaces at the New Idria mine has cost (including condensers, and other necessary equipment) about $200,000, and it is expected that it will soon replace not only the concentration plant but the coarse-ore furnaces as well. In a plant of this size, where the cost of skilled labor and dependable power may be distributed over a large tonnage, the installation will doubtless prove satisfactory and economical. On the other hand, the operating costs might be something of a burden at a small mine, as compared with the extreme simplicity of the old-fashioned Scott furnace.

The condensation problem seems to have been fairly well solved, and the research work by the Bureau of Mines has proved that the condensation losses in a carefully managed plant are small. The use of tile pipe condensers is in accord with the best European practice, and should considerably reduce the first cost of a condenser plant as compared with the old system of brick and wood condensers.

Arsenic in 1918

In the autumn of 1917 the arsenic situation was bad, owing to the cutting off of imports. The pre-war prices averaged 4c. per lb., but at the end of February, 1918, the prevailing price had risen to 15c. per lb., owing to the scarcity of the metal. Because 60% of the arsenic consumed in the United States is utilized in the manufacture of insecticides, the United States Food Administration called a meeting of the arsenic producers and agreed upon a price of 9c. as being large enough to yield a profit to the producers. This price fixing did not help the arsenic situation much, as contracts for the 1918 supply had already been made.

The annual consumption of the United States is equivalent to 12,000 short tons of arsenious oxide. The domestic production in 1917 was 6151 tons, and that of 1918 is estimated to be 20% greater. The principal domestic producers are the American Smelting and Refining Company's smeltery at Denver, Colo., and the Washoe Reduction Works at Anaconda, Mont., with 120 and 300 tons production, respectively, per month.

War demands increased the requirements for arsenic. Shipments were made to England and South America, whereas, previous to the war, England was supplied by her colonies and exported insecticides to South America.

The Anaconda Copper Mining Co., at a cost of $1,225,000, recently added new equipment in the form of additional stacks and flues and the installation of the Cottrell system for arsenic precipitation. The output of the company will in the near future equal the present entire annual demand of the United States.

Metallurgy of Zinc

By W. R. INGALLS

IN REVIEWING the progress in a branch of metallurgy during a year just elapsed it is conventional to begin with the statement that there was nothing new. However, it is probable that that statement cannot be truly made for any branch of metallurgy in any year. In the metallurgy of zinc in 1918 there may not have been any striking revelations of new principles, but certainly there was a good deal of new thought, tending toward improvement in the art.

Roasting—There is perhaps no branch of the metallurgy of zinc in which there is more need for improvement than there is in means and methods for desulphurizing blende. The increase in supply of flotation slimes has simply aggravated old difficulties. Practice has settled down upon the Hegeler, Merton, Ridge, and Spirlet as the standard mechanical muffle furnaces, but among these only the Hegeler finds general application. Mr. Rissmann and his assistants have remodeled the Spirlet furnace, and find it satisfactory, but other American smelters who have tried it have not been so well pleased. Similarly, the Merton and Ridge furnaces have come into occasional use, especially in Great Britain, without as yet meeting with general approval elsewhere. The Wedge furnace has possibilities, but has not yet been tested adequately under conditions where dead-roasting is necessary. In places where hand-raked furnaces are still permissible, by virtue of labor conditions, the Delplace would probably be adopted in preference to any other.

Mr. Rissmann wrote me recently that he thought that entirely too little attention had been paid to the roasting of ore. He, and his aids, formerly entertained the conventional opinion that when the sulphur is low in the roasted ore there would be good results in the distillation. They have found in some cases, however, especially in the roasting of flotation slimes, that there are better results with 2.5% sulphur left in the ore, providing the roasting conditions were right, than there are with only 0.5% sulphur left in the ore when the roasting conditions were wrong, referring especially to too great excess of air. They find, moreover, that ore roasted without too much excess of air will sinter and become more porous and otherwise favorable for distilling than ore roasted with too great an excess of air. Bearing upon this subject is the remarkable experience in desulphurizing blende at Port Pirie that has been reported this year.

The Dwight & Lloyd sintering process has been applied by C. N. Warner and Gilbert Rigg with promising results for the desulphurization and sintering of zinc sulphide concentrates at the Port Pirie smeltery of the Broken Hill Associated Smelters, Proprietary, Ltd. It has been found practicable to reduce flotation concentrates from 26% sulphur down to less than 1½% sulphur at a very rapid rate. A portion of the gas, but not all, may be used for sulphuric acid manufacture. The desulphurization seems to be remarkably cheaper than in even the best types of roasting furnaces, and the first cost of plant is much smaller. Moreover, the sintered product gives astonishingly improved results in distillation, it having been found possible at Port Pirie to charge the retorts with 16.6% more ore with the use of 10% less of reduction material, while recovery of zinc increased 4.3% and there was slightly less loss of retorts. These figures were obtained by four months of operation with roasted and sintered blende, 50 tons per day being used, compared with the previous record of six months when the furnaces were distilling ore roasted in Hegeler kilns.

Distillation Furnaces—American zinc-smelting practice has settled down to two types of distilling furnaces, viz. the Hegeler and the Neureuther modification of the Siemens-Belgian. Only at Pueblo has the Rhenish type of furnace come into steady use in this country. This is the more interesting inasmuch as the Rhenish type of furnace is the favorite in Europe, and the new and modern metallurgy of zinc in Great Britain is trending strongly in its direction.

At Peru and Depew, Ill., the Siemens-Belgian furnaces use only 0.9 ton of heating coal per ton of ore charged into the retorts. At Rose Lake the ratio is about 1:1. Between Rose Lake and Hillsboro, which are owned by the same company and are under the same metallurgical direction, we are able to get a good comparison of the Siemens and Hegeler furnaces. Rose Lake, with Siemens furnaces, uses about one ton of heating coal per ton of ore distilled and uses an additional half ton for the generation of power, a total of 1.5 tons per ton of ore. Hillsboro gets its power from waste-heat boilers, but its furnaces require about 48 tons of coal for distilling 18 to 20 tons of ore, or about 2.5 tons per ton of ore, wherefore Rose Lake is about a ton ahead of Hillsboro. Each plant uses about 0.5 ton of coal per ton of ore in roasting.

Mr. Ziesing has patented a modification of the Hegeler-Iola furnace in which the combustion gases pass longitudinally through the laboratory of the furnace. Between each section of retorts (4 x 5) he introduces a wing-wall extending outward nearly to the front of the furnace. The idea is to cause the burning gases to travel near the front of the furnace and eddy back in the several sections, with a view to securing a more uniform heating of the retorts. Mr. Ziesing tells me that he is building all of the Grasselli furnaces along these lines, and reports that "as in most cases of this kind, it is a difficult matter to state in absolute figures just what the advantages are." He feels, however, that he gets better results by reason of the fact that the fronts of the furnaces become hotter. The fact that the front half of the retort ordinarily, on account of the radiation, is colder than the rear half of the retort, is a matter that he has been trying to overcome for a long time, and by various means. He is also of the opinion that the furnace is more easily controlled as to uniformity of heat and that there is a slight saving in fuel consumption.

Distilling Practice—More and more attention is given to proper compounding of the charge, especially as to slag constituents. O. Mühlhaeuser, in *Metal u. Erz*, 1918, 15, pp. 303-305, says: "The amount of slag formed in the retorts during distillation should be small, and its composition should be controlled by mixing the charge

in suitable proportions, so that it has as little action on the retort as possible. An average slag sample obtained by distilling a mixture of Joplin and Wisconsin ores was found to have an oxygen ratio of 1:2.8, approaching that of a trisilicate. It was very viscous at distillation temperatures and formed an internal coating, the thickest part of which was on the bottom of the retort. The latter was thus protected from corrosion, and the loss of zinc by escape vapor was decreased."

Behavior of Silver in Zinc Distillation—Butte & Superior ore assays 50.5 to 53.2% Zn, 2.4 to 4.7% Fe, 0.22 to 1% Mn, 2.4 to 3.6% Pb, 0.33 to 0.50% Cu, 11.6 to 14.1% insoluble, and 0.03 oz. Au and 14 to 18.5 oz. silver per ton (2000 lb.). One ton of spelter is obtained, roughly speaking, from 2.5 tons of ore containing 40 oz. silver. Of this spelter about 35% is derived from the first draw, 50% from the second, and 15% from the third. Spelter of the first draw assayed 0.164 oz. silver per ton and 1% Pb; of the second, 0.583 oz. silver and 1.5% Pb; of the third 1.178 oz. silver and 2.25% Pb. These analyses show that very little silver goes into the spelter. The first draw occurs 2.5 hours after charging and comprises the spelter distilled at the lowest temperature, wherefore the relatively low lead and silver contents. With the progressive increase of temperature, more lead and silver go over. The bulk of the silver remains in the residue. In a test extending a little over two years, figuring back to raw ore, the weight of the residue was 46.75% and its content of gold was 88.14%; of silver, 77.4%; of copper, 78.5%, and of lead, 47.75% of what was in the raw ore. The silver and lead figures for spelter and residue will not check back to the original ore, owing to losses in roasting. These data show that the loss of silver and gold in zinc distillation is very small.

Zinc Burning—The River Smelting and Refining Co. smelts partially desulphurized ore in reverberatory furnaces at Canyon City, Colo., the proper quantity of reducing material being added to the charge. By proper management it is said that slags low in zinc can be made. The volatilized fume is collected by bag filtration and is shipped to Keokuk, Iowa, for further treatment. At Keokuk the fume is dissolved in sulphuric acid and the solution of zinc sulphate is electrolyzed.

At Great Falls, on the other hand, Mr. Laist is reported to have given up the expulsion of zinc in his reverberatory smelting and is now volatilizing only the lead, letting the zinc go into the slag. The old principles of metallurgy obtain pretty well. If a highly siliceous and calcareous slag be made, zinc can be kept out of it to a large extent. Slag assays of 3% or even 2% zinc are not unreasonably to be expected. However, such slags require high temperature and may necessitate the introduction of barren slag-formers into the charge; wherefore it may be more profitable to make an ordinary ferruginous slag and let the zinc go into it.

Electrolytic Extraction—More and more is it evident that the greatest difficulties in the electrolytic process precede the electrolysis itself. Given the right kind of electrolyte, there is no great difficulty in performing the electrolysis; but it may be costly to remove impurities in the hydrometallurgical part of the process in order to obtain the right kind of electrolyte. Also, there may be difficulties in making an adequate extraction of zinc in leaching the ore. Mr. Laist ran up against the old difficulty from gelatinizing silica, and he has had to introduce a rather round-about method of dehydrating the silica and rendering it insoluble, which method is described in patents issued to him Oct. 8, 1918 (U. S., 1,281,031 and 1,281,032).

Metallurgy of Lead

By H. O. HOFMAN*

EVERY lead refinery using the Parkes process for desilverizing lead bullion has Faber du Faur retort furnaces for distilling liquated zinc-silver crusts. The inventor, whose furnace came into use in 1870[1], died at Newark, N. J., Aug. 18, 1918, in his 92nd year[2]. He was born in Würtemberg, Germany, came to this country in 1850, served in the Civil War and was commissioned a captain. Later he engaged in engineering work. He was the first man to design a tilting furnace, which permitted pouring of metal without disturbance of the crucible. When his patents lapsed, the various distilling apparatus in use were replaced by what has become the standard furnace.

In the practice of smelting lead ore and refining lead bullion there were no radical changes in 1918, but improvements made in the general arrangement of plant and in the details of operation show that lead metallurgy is not stationary, even if the principal features have become largely standardized. This is brought out clearly in the new treatise on the "Metallurgy of Lead" by the present writer[3], especially when its content is compared with that of the preceding edition.

Lead Smelting Practice

The "Report of the Smelter and Ore Investigation Committee, State of Colorado, 1917,"[4] prepared by O. R. Whitaker, deals in a thorough manner with a question that has been and is still a bone of contention between the ore producer and consumer. It analyzes the schedules in use in Colorado in the period of 1912 to 1916 and represents graphically the values of and the charges made for the different grades of ore, thus furnishing definite information of the actual state of affairs. The ores treated by the Colorado smelting works in this period averaged Au 0.526 and Ag 12.34 oz. per ton, Cu 0.61, and Pb 6.76%. To obtain a Pb-content of charge of 12%, outside lead ore had to be brought in. The lead slags made assayed 0.002 to 0.005 oz. Au and 0.50 to 1.0 oz. Ag per ton, 0.20 to 0.30% Cu, and 1.0 to 1.50% Pb. With blast-furnace charges containing from 8 to 10%

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[1]Eilers. *Trans.* A. I. M. E., 1874-75, Vol. 3, p. 315.

[2]*Eng. and Min. Journ.*, Vol. 106, p. 368.

[3]McGraw-Hill Book Co., New York, 1918.

[4]Denver, 1917; reprint in the *Metal Mining Journal*, Denver, Nos. 8 and 9, Dec., 1917, Jan., 1918; comment, *Eng. and Min. Journ.*, Vol. 105, pp. 539, 626.

Pb, the amount of slag made represented from 60 to 65% of the charge, or one ton of slag for each ton of ore. The matte fall was about 10%, the matte assaying Au 0.05 oz. and Ag 40.0 oz. per ton, Cu 10%, Pb 15, Zn 10, Fe 40%. The second or converting matte contained 40% Cu. The baghouse product assayed Pb 40 and Zn 10%. The losses in smelting were Au 0.005 oz., Ag 1 oz., Cu 6 lb. and Pb 30 lb. per ton of ore. In treating 3,140,018 tons of ore, a net profit of 95c. per ton was realized.

Modern Silver-Lead Smeltery

A comparison of the older smelteries, in which materials are handled mainly by manual labor, with a modern plant which employs machinery wherever it is feasible, brings out in a striking way the changes that have been made in the construction of lead plants. G. C. Riddell[5] has given the layout of a silver-lead smeltery which he considers meets all modern requirements. The plant is to treat daily from 1000 to 3000 tons charge and is to be erected on level ground which has a declivity on one side to serve as slag dump. Standard-gage tracks and a complete railroad circuit of the plant, with a loop-system for the charging of the blast furnaces, large storage capacities, automatic conveying and weighing, duplication of vital units in handling apparatus, and ample supply of electric power and water, are essential features.

The sampling mill, with a capacity of 50 tons of ore per hour, has a gyratory crusher, rolls, and Vezin samplers. The roasting division is provided with a Wedge furnace for pyritic material and a Dwight & Lloyd double roasting plant for leady ores. Three 42-in. machines are required for rough roasting and four machines of the same size for re-treating and sintering the rough-roasted material after it has been crushed. The smelting section has three blast furnaces, 52 by 180 in. at the tuyères, and a 25-ft. working height, provided with individual blowers supplying from 6500 to 8000 cu.ft. air per min. at a blast pressure of 60 to 70 oz. The proposed great height is borrowed from Australian practice. At the Cockle Creek plant, New South Wales, satisfactory work with ores running high in zinc was obtained only when the active height of the furnaces was increased to 25 ft. A furnace puts through, with 11.0 to 11.5% coke, 550 tons of charge per 100 sq.ft. hearth area in 24 hours, making slags with 12 to 13% ZnO and only 0.75 to 1.00% Pb. The furnaces have thimble tops, which consist of a central flue extending from the feed floor a short distance into the open top of the furnace for the withdrawal of gases, and being surrounded by the charge, which is fed from the side. The gases from the roasting and blast furnaces pass through dust flues and chambers and are freed from the remaining dust and fume by Cottrell treaters before they pass into the open. The treaters[6] are in four sections, each with 64 pipes, 12 in. in diameter. The gases pass downward through the pipes instead of upward, as is usually the case.

Working details of the new smeltery and refinery of the Bunker Hill & Sullivan Mining and Concentrating Co. have been given by C. T. Rice[7]. This plant[8] has made some important changes since it went into blast, on July 5, 1917. One of these is the use of pulverized coal for firing reverberatory furnaces, kettles, and retorts, besides heating a 150-hp. Geary boiler. The Bonnot system of pulverizing coal and separating the dust is in use. The pulverizers crush 20 tons of slack coal in an eight-hour shift; screen tests of the finished product show that 5% remains on a 100-mesh and 85% passes through a 220-mesh screen.

The roasting division was planned to have one Wedge roasting kiln, 21 ft. 6 in. in diameter, for pyritic ore, and four standard Dwight & Lloyd 42-in. sintering machines for leady ores. A rotating circular cast-iron cooling hearth, with stationary rabble-arm, has been added to the Wedge kiln, in order that the product may be air-cooled and sprayed before it is delivered to a traveling belt which carries the components of the blast-roasting charge. It was necessary to add three Dwight & Lloyd sintering machines to the existing four on account of the increase of blende in the charge. The pallets are provided with the self-cleaning grates such as are in use at Trail, British Columbia.

In this connection it may be stated that the clogging of the slots in the grate is governed largely by the care given to the making-up of the charge. Some smelteries have a grate cleaner for two machines; others have dispensed with grate cleaners entirely.

In the smelting division, one working blast furnace, 48 x 180 in. at tuyères and 14 ft. high, has been added. The blast is furnished by two Ingersoll-Rand turbo blowers, each having a capacity of 12,000 cu.ft. of free air per min. at a pressure of 48 oz. per sq.in. A furnace has two fore-hearths in series. The first is 6 ft. in diameter and 3.5 ft. deep; the second 5 ft. in diameter and 2.5 ft. deep. They are handled by the overhead crane. The waste-slag pots have a capacity of 130 cu.ft. The charge carries from 35 to 40% Pb, but only from 1 to 3% Zn. Slag analyses show SiO_2 32 to 33%, FeO 32, MnO 3, CaO 16, ZnO 2 to 4%, and Pb 1% (wet). The matte fall is 12%. A furnace puts through in 24 hours from 200 to 250 tons of charge and produces from 120 to 150 tons of dressed lead bullion.

The refinery, which uses the Parkes process, has been enlarged by two 80-ton softening furnaces, two 50-ton desilverizing kettles, one silver refining furnace, and a reverberatory furnace for the treatment of skimmings. The lead bullion from the blast furnaces is collected in two 50-ton drossing kettles, and the drossed bullion transferred by means of a Miller pump into the softeners. The mode of operating is the same as in other modern plants with the exception of the firing, in which coal dust is used, as noted above. The initial difficulties with the use of this fuel appear to have been overcome, but details are not now available.

The market lead is molded from four 50-ton merchant kettles with Miller casting machines. Four men with a machine cast and load into cars 20 tons of pig lead per hour in 100-lb. pigs. The market lead has the following composition: Pb 99.989, Sb 0.002, Cu 0.0005%, Zn trace, As none, Bi none, Ag 0.15 oz. per ton. The doré silver is parted with sulphuric acid, and the silver from the sulphate solution is precipitated in lead-lined tanks with copper strips. The cement silver is transferred in a car to and melted in a double Monarch furnace and poured from it into bars.

[5] *Eng. and Min. Journ.*, Vol. 106, p. 115.
[6] *Eng. and Min. Journ.*, Vol. 106, p. 120.
[7] *Eng. and Min. Journ.*, Vol. 106, pp. 91, 436, 649, 743, 771, 993.
[8] *Eng. and Min. Journ.*, Vol. 103, p. 50; Vol. 105, p. 93.

The smeltery at El Paso, Tex.[9], which started in the early 80's as a lead plant, has changed in the character of its work to such an extent that lead has become of secondary importance in comparison with copper. However, there are in operation five lead blast furnaces, 46 x 162 in. in section, with a charge height of 19 ft., each treating 145 tons charge per day, containing 10% Pb and 1.5% S. Since the last notice of this plant[10], the principal change has been the adaptation of thimble tops to the blast furnaces, which have downcomers at one end beneath the feed floor to carry off the gases. The throat of the furnace has been enlarged. Along the center line there has been placed an oblong iron box consisting of two truncated cones joined at the bases. The upper cone is 1 ft. 6 in. high and 4 ft. wide, and the lower 4 ft. high and 3 ft. 5 in. wide. The box, which is 7 ft. 8 in. deep and reaches to the ends of the furnace, extends 2 ft. 8 in. beneath the lower edge of the down-comer. Between the box and the furnace wall is a charge space 2 ft. wide. The work with the improved top has met all expectations.

The earlier lead plants gave little attention to carrying off the dust and fume set free in the various mechanical and chemical operations. The men became "leaded" and were replaced. The advance made in recent years is striking. Wherever dust is produced in crushing and sampling, or dust and fume in roasting, smelting, or refining, appliances are provided to carry off the noxious products at the places where they are formed. Practical experience has shown that these sanitary measures are not always an additional expense; on the contrary, filtering of the gases and the recovery of the dust and fume have more than paid for the cost of collections. Safety appliances[11] have been introduced at most plants, which make the work less hazardous than it was formerly. Further, cleanliness and order are enforced, which leads new men along the path of becoming interested in safety work. Accident records of the divisions of a plant are kept separately, so that a rivalry is created, which is also fostered by premiums. The result has been a great reduction of accidents and sickness among the employees.

Metallurgy of Copper

By ARTHUR L. WALKER*

THE energies of copper smelters and refiners in 1918 were directed principally toward maintaining a maximum production to supply the Government and our Allies with the metal required for war purposes. Their operations were successful, and an ample supply of copper was maintained, although at times the amount on hand was dangerously low. This result was obtained despite great difficulty in securing a sufficient amount of labor to run the plants and refineries, even at the high wages offered. Not only has labor been scarce, owing to the heavy demand, but it also has been most inefficient. In many of the copper plants the amount of work performed per hour or per day has fallen very much below normal. An enormous increase in operating expense has resulted, and this is especially true in the case of copper refining, where the costs are more than double those of the period preceding the war.

Little Construction Possible

At the beginning of the year 1918, the capacity of the smelting plants and refineries was sufficient to treat the ore mined and crude copper produced, in spite of the fact that mining operations were largely increased in many properties. This was extremely fortunate, as it would have been impossible to build smelting plants and refineries, to treat any increased production, within a reasonable length of time. For this reason little, if any, new construction was attempted.

The only smelting plant put in operation was that of the United Verde Extension Mining Co.[1] The first unit of this plant was blown in July 18, 1918. The plant is arranged for extensive bin capacity, so as to carry and handle in an economical manner a large supply of ore.

The flues for collecting dust are elaborate and are laid out so that the dust-settling facilities are ample. If, however, it is later found necessary to install additional dust-collecting apparatus, Cottrell treaters may be used, especially in case increased capacity reduces the efficiency of the present system. The one blast furnace installed is 48 in. x 26 ft. 8 in. long and has a capacity of about 600 tons of charge per day. The ore for the reverberatory furnaces is roasted in six 21 ft. 6 in. Wedge furnaces and is then taken directly to two reverberatory furnaces 25 ft. wide x 120 ft. long, each of which treats from 500 to 600 tons of charge per day. The copper matte from the blast furnaces is converted in three 12 ft. converters of the Great Falls type. An interesting feature is the use of pulverized coal, not only in the reverberatory furnaces but also in the direct-fired boilers, thus entirely replacing fuel oil, which has been used extensively in Arizona.

The new roasting plant of the Consolidated Arizona Smelting Co.,[2] at Humboldt, Ariz., consisting of four Wedge roasting furnaces, each 22½ ft. in diameter, is arranged so that the gases from the roasting furnaces are treated by the Cottrell system in a most effective manner. These gases are carried upward from each furnace through proper flues to individual duplex Cottrell treaters, where the dust is precipitated and conveyed by pipes to hoppers below. By this means, not only the coarse dust, which is usually collected in the flue in the roasting buildings and returned directly to the roasters, is caught, but also the fine dust is immediately precipitated and returned to the furnaces for treatment. The clear gases from the treaters escape through individual stacks 4 ft. in diameter and 30 ft. high. This plant was completed and put into operation in 1918.

[9]de Kalb, *Min. and Sci. Press*, Vol. 116, p. 679.
[10]*Eng. and Min. Journ.*, Vol. 101, p. 89.
*Professor of metallurgy, Columbia University, New York.
[1]*Eng. and Min. Journ.*, Vol. 106, p. 690.
[11]Douglass, *Eng. and Min. Journ.*, Vol. 106, p. 105.
[2]*Min. and Sci. Press*, Vol. 116, p. 335.

An interesting development in the settlement of matte from copper blast furnace slag has been made at the Granby smeltery[3], Grand Forks, British Columbia. The matte and slag tapped from the furnace are run through five settlers in series. The arrangement is such that each furnace has three independent settlers, and, after passing through the settlers, the slag from two furnaces is combined and run through two more settlers in series. The heavy flow keeps the last two settlers hot. After passing through the five settlers, the slag is granulated by four jets of water, the water being delivered under a pressure of 50 lb. through nozzles ⅝ x 2 in., and falls into a launder, where it is carried away by overflow water from the jackets. For each ton of slag, 1400 gal. of overflow water and 800 gal. of pressure water are required. Placing the settlers in series reduces the danger of loss of matte in the granulated slag, as the arrangement for settlement is so perfect.

Heap-Leaching Experiments

Some experiments in heap leaching, which may have an important bearing on the future treatment of low-grade lump ore, have been and are being conducted on a large scale in the southwestern copper centers. At Bisbee, Ariz., the Phelps Dodge Corporation has a heap of about 10,000 tons which is being treated by leaching. At Tyrone, N. M., the same company has another experimental heap of about 20,000 tons, and at the latter place plans have also been made for a systematic investigation of the subject, and a large leaching plant has been designed. At Santa Rita, N. M., the Chino company[4] is building a pile containing about 90,000 tons, and this is probably under treatment at this time.

In the experiments made to date it is estimated that the treatment of these large heaps or piles will last for three years, during which period 40% of the copper content in the ore will be extracted during the first year, 20% during the second year, and 15% during the third year, making a total extraction of 75%. It is thought that the time required to extract any portion of the remaining copper will make it unwise to conduct the operation further.

The difficulties connected with heap leaching are well understood. By taking Rio Tinto practice as a basis, and making the necessary changes such as experience dictates, it is hoped that these difficulties will be overcome. It has been found difficult to pile the ore so that the coarse and fine portions will be arranged in such a manner that channeling will not occur, and loss due to solutions penetrating into the ground is hard to provide against. The amount of ferrous and ferric sulphate in the solution is important, though ferric sulphate is desired for leaching, and excess in the liquor running to the precipitating tanks causes an excessive consumption of iron. It is now stated that under favorable conditions heap leaching will probably become commercially possible, and the experiments will be watched with interest.

The successful results which have attended other leaching operations started in recent years are gratifying. One of these is the leaching plant at Ajo, Ariz.,[5] where an interesting point is the method of treating the iron in the solution after it leaves the last leaching tank. The solution is sent to sulphur dioxide towers so that any ferric sulphate formed will be reduced to ferrous sulphate before the solution enters the electrolytic department. This is necessitated by the fact that ferric sulphate is an excellent solvent for freshly precipitated copper. The solution as delivered to the electrolytic tanks is complex in its composition, and consists of from 30 to 20% of its weight in sulphates. The copper content is 2.6%, and the total amount of iron in both ferrous and ferric state is between 2 and 3%, and, in addition, there is almost 3% of alumina.

The new leaching plant of the Utah Copper Co.,[6] designed to handle the oxidized capping that is stripped from above the principal mass of sulphide orebodies in Bingham Canyon, is giving satisfactory results. The capping contains about 0.65% copper, which is largely in the form of carbonates. The plant has a capacity of 2000 tons of ore per day, and is arranged so that the material is handled mechanically, with the smallest amount of labor.

The leaching vats, of which there are 12, are made of heavily reinforced concrete and are 100 ft. wide, 50 ft. long, and 17.5 ft. deep. The solution passes through 10 of these vats in series, beginning with the vat from which most of the copper has been leached and leaving the vat which contains a fresh charge of ore. Only 10 vats are in operation regularly, one being filled with fresh ore while another is being emptied. Acid is added to the solution after it has passed through three vats, so as to raise its acid content. In passing through the last seven vats, the free-acid content is gradually reduced, as sulphates are formed. The enriched solution from the last vat in the series contains about 3.1% copper, 0.35% iron in the ferrous state, 0.95% iron in the ferric state, and 0.20% free sulphuric acid. The copper-bearing solution is conducted from the leaching vats through wooden stave pipes to the precipitating vats, which have a total length of about 2700 ft., a width of 9 ft. and a depth varying from 6 ft. to 3 ft. In these vats the copper is precipitated on iron.

New Anaconda Fume-Dust Collector

The Anaconda Copper Mining Co. is constructing a plant[7] on an enormous scale for collecting dust and fume, which will be the most notable equipment of its kind in America. Gases from the entire plant will be conducted to main flues running up the hill in a northerly direction from the present 300-ft. stack. It is estimated that 3,000,000 cu.ft. of gas per min. will pass through these flues. The gases will be discharged from the flues into Cottrell treaters, of which there will be 20 of the Anaconda plate type, where it is estimated 240 tons of solids per 24 hours will be recovered, equivalent to 88% of the dust now going to waste. From these treaters the clear gas will pass into the new stack. This stack will be 60 ft. in diameter at the top and stand 525 ft. above its concrete foundation. As this foundation is 454 ft. above the level of the reverberatory furnaces, the new stack will equal a draft column of 979 ft. In addition to the 3,000,000 cu.ft. of gas delivered to the stack, 1,000,000 cu.ft. of cooling air will be admitted, so that

[3] *Min. and Sci. Press*, Vol. 116, p. 819.
[4] Private communication.
[5] *Min. and Sci. Press*, Vol. 116, p. 187.
[6] *Min. and Sci. Press*, Vol. 117, p. 787.
[7] *Min. and Sci. Press*, Vol. 116, p. 895.

the stack will carry a total of 4,000,000 cu.ft. per min. of air and gas, at a velocity of 24 ft. per second. The flue dust and fume collected will be smelted in a special reverberatory furnace, 20 ft. x 120 ft., having a capacity of 240 tons of fume dust and 155 tons of calcine, flux, and other material per day. It is expected that there will be an output of about 50 tons of matte and 200 tons of slag per day from this furnace. The fume discharged from the reverberatory furnace will contain considerable dust and also all of the arsenic, which is volatilized. The gas containing the dust and volatilized arsenic will be passed through hot Cottrell treaters, where the dust will be precipitated. The escaping arsenic fume will be then passed through a flue into which cold air will be introduced to bring the temperature down sufficiently to allow the arsenic to be deposited. The arsenic fume will then be deposited out in a cold Cottrell treater. It is expected that about 35 tons of arsenic, 92 to 95% pure, will be recovered each day.

Refining Capacities Unchanged

Little if anything was done in 1918 in the way of extensions or improvements in copper-refining operations, the maintenance of production having been difficult without considering additional construction.

The effect that smooth anodes have on the efficiency of deposition is being carefully considered, and the importance of this subject has not been lost sight of. At the U. S. Smelting, Refining and Mining Co.'s plant an extraordinary amount of care is taken in casting operations and in spacing the anodes so that the distance between electrodes is as small as possible, thereby decreasing power consumption, and, at the same time, the condition of the anode and cathode sheets is maintained at such a degree of excellence that the danger of short-circuiting is reduced to a minimum. The subject is also being studied carefully at the Raritan Copper Works,[8] Perth Amboy, New Jersey.

At the American Smelting and Refining Co.'s plant, at Maurer, experiments in using pulverized coal in reverberatory copper melting furnaces have been conducted for some time. At the beginning many difficulties were encountered, but these have been gradually overcome, and it is now the opinion of some refiners that pulverized coal will be extensively used for reverberatory furnaces in which copper is melted. The great trouble in the use of this class of fuel, as shown by the experiments at another plant, occurred in arranging for a proper distribution of heat and also in taking care of the ash, a much more troublesome proposition in a copper-casting furnace than in a reverberatory furnace used for smelting ore.

Union Miniere du Haut Katanga Operatons in the Belgian Congo

The operations of the Union Minière du Haut Katanga Co., Belgian Congo, Africa, present a most interesting proposition and one which carries one back to the smelting practice of the old days in the southwestern part of the United States. The ore is rich, containing from 10 to 15% copper, and the cost of fuel is extremely high (coke costing $35 a ton). At present the slag contains at least 2% copper, and probably more, which is similar to the slag turned out in Arizona 35 years ago. The company's production of copper in 1918 will be approximately 24,000 tons of black copper, containing 97% copper, which is about 3000 tons less than in the year 1917. The six or seven furnaces[9] which the company now has, when running full capacity on 10 to 15% ore, are capable of producing from 35,000 to 40,000 tons of black copper per year.

A leaching plant has been designed for this company which will have sufficient capacity to produce between 50,000 and 55,000 tons of copper per year, but this plant will probably not be in operation for three or four years.

Metallurgy of Gold and Silver

By A. W. ALLEN

PROGRESS in the metallurgy of gold and silver has been hampered by war conditions, which precluded extension of operations in most instances. Work in connection with the production of silver has been encouraged by fairer prices, which, in the case of one important district at least, have been shown[1] to counterbalance the increased cost of operations.

All the principal producers of gold were told by their respective governments that the maintenance of output was imperative, and that they must consider themselves as directors of an essential war industry. Patriotic action was taken in a large number of instances, and work was continued where, economically speaking, it should have been discontinued.

Under these conditions technological progress has not been so vigorous as it might have been, but, at the same time, it is difficult to review the year 1918 without noting that gold metallurgists are alive to the need of keeping abreast of the times, and that sufficient enterprise and initiative exist to counteract any *laissez faire* policy. It is notable that a broader view is now being taken of the activities in other countries; and the brotherhood of arms which was recently consummated between the representatives of the world's principal gold- and silver-producing countries, on the European battlefields, will doubtless persist in the form of a welcome catholicity of view as regards foreign practice.

Visit of A. I. M. E. to Colorado

The visit of the American Institute of Mining Engineers to Colorado for the autumn session served to draw attention to Cripple Creek practice. A number of informative papers were published, which were, moreover, of general interest to metallurgists.

The value of continued research, and the variation

[8] *Eng. and Min. Journ.*, Vol. 106, p. 95.

[1] "Effect of the War Upon Tonopah Mining," by Jay A. Carpenter, *Eng. and Min. Journ.*, Oct. 5, 1918, p. 601.

[9] Private communication.

existing under conditions which are, to a considerable extent, similar, were shown by the work of T. B. Crowe, whose recommendations with regard to the deoxidizing of cyanide solutions are radically different from those to be inferred from proved practice at the only other sulpho-telluride gold camp of importance—Kalgoorlie—about 17 years ago. Conditions are varying constantly, and practically every phase of the original process is in operation in some modified form. The need for greater economy is apparent, and so continued investigation and experimentation are not only justified but imperatively necessary, to avoid the error of assuming that a proved fact is inviolate, regardless of altered circumstances.

New Records for Efficiency

The results[2] for the year ended Mar. 31, 1918, at the plant of the Dome Mines Co., Ltd., Porcupine, Canada, are of exceptional interest. The tonnage milled amounted to 247,000, and, whereas the gold in the head sample was worth only $4.272, $4.173 was recovered as amalgamation and cyanide bullion. This showed an actual recovery of 97.676%, and a loss in residue of less than 10c. per ton. Although there is little justification for detracting from such an excellent showing, the question of economic limit of fine grinding in cyanidation might be raised. There are other instances where the excessive reduction in particle size has been deemed impracticable, on account of the expense. Reduced to terms of percentage, the achievement, however, is significant. After amalgamation, the ore contained only 0.00021% and the residue assayed 0.000015% of gold.[3]

Cyanide consumption is being reduced to an almost unbelievable point in some plants. The results[4] at the Victor mill of the Portland Gold Mining Co. for six months of 1917 indicate that the amount of NaCN used has been lowered to 0.175 lb. per ton of ore. This is a creditable showing, and close to the record for the City Deep plant, at Johannesburg, for the month of August, 1917, when a consumption of 0.169 lb. per ton treated was recorded. High zinc consumption usually accompanies high cyanide consumption. Economies are, likewise, usually in synchronism. The Portland company's showing of 0.191 lb. of zinc dust per ton of ore treated exhibits a considerable saving as a result of the introduction of the Crowe modification.

Amalgamation Practice

Practically nothing new was evolved during 1918, although various minor economies have been effected in certain districts. An excellent treatise on gold dredging in the United States[5] has drawn attention to the value and status of amalgamation in connection with one of the most important sources of the yellow metal.

The relation of amalgamation to cyanidation has been discussed at length[6]; and interesting notes have been published on amalgamation practice and economies[7], grease amalgamation of gold[8], and other phases of treatment.

An excellent summary[9] of the available information on the loss of quicksilver in amalgamation plants is supplemented by views and deductions of interest and value. This review is particularly pertinent at the present time, when there is so much misapprehension as to the facts relating to amalgamation practice. This may be exemplified by the circumstance that an important source of public information can publish the statement, apparently without fear of contradiction, that amalgamation in Colorado results in the loss of about 26 lb. of quicksilver per ton of ore treated!

South African Metallurgical Progress

South African practice at the principal gold-mining area—the Rand—has been standard for many years, and few modifications have been made. The primary method of gold recovery is by amalgamation, and the percentage of the metal obtained by this system has not been decreasing during recent years, despite positive statements to the contrary. Actual statistics are as follows:

RAND GOLD OUTPUT STATISTICS 1914 to 1917

Year	Total Yield Fine Gold, Oz.	By Amalgamation — Yield Fine Gold, Oz.	By Amalgamation — Per Cent of Total
1914	8,372,070.199	5,298,738.430	60.8
1915	9,071,339.581	5,730,631.125	63.1
1916	9,269,682.453	5,908,595.756	63.6
1917	8,995,898.571	5,725,482.675	63.6

There is no reason to assume that there will be any material difference in the proportionate recovery by amalgamation for 1918.

The outstanding feature of metallurgical practice on the Rand is the retention of the original method of milling in alkaline water, which permits such a comparatively high recovery of gold by amalgamation, and leaves a tailing in ideal condition for cyanide treatment. A further characteristic of procedure in this important district is the recognition of the cheapness of leaching large tonnages of comparatively finely ground ore in open vats.

Statistics show that minor improvements in operation are constantly being effected, one of the largest groups, controlling a number of important mines, reporting reduced gold content in residue, with increased actual recovery, of 97%, being obtained from comparatively low-grade ores without the adoption of sliming.

The gold-mining industry in South Africa, as in other parts of the world, has received no preferential consideration; neither has its income been adjusted to couterbalance the increasing cost of mining and treatment as compared with a stationary selling value of product. It is a testimony to the soundness of the fundamentals of Rand metallurgical practice that the district has more than held its own during the recent war crisis, its proportionate contribution to the world's supply of gold having risen steadily, in spite of all disabilities, from 38.3% in 1914 to 42.58% in 1917. When statistics are available it will probably be found that the last-named figure has been maintained or exceeded in 1918.

The Reinstatement of Charcoal as a Precipitant

The difficulty in obtaining supplies in isolated districts, and the increased cost of the necessary materials, have led to the achievement of many economies, and to

[2]Seventh Annual Report, Dome Mines Co., Limited.
[3]*Eng. and Min. Journ.*, Oct. 12, 1918, p. 680.
[4]"Effect of Oxygen in Precipitating Gold From Cyanide Solutions," by T. B. Crowe. *Trans.* A. I. M. E., 1918.
[5]Chas. Janin, Bull. 127, U. S. Bureau of Mines.
[6]A. W. Allen, *Met. and Chem. Eng.*, May 15, 1918. p. 515.
[7]A. A. Pearce, *Eng. and Min. Journ.*, Nov. 2, 1918, p. 792.
[8]H. A. White, *Eng. and Min. Journ.*, Nov. 23, 1918, p. 904.
[9]W. J. Sharwood, *Min. and Sci. Press*, Apr. 6, 1918, p. 483.

the exercise of not a little ingenuity among cyanide engineers. One of the most interesting developments in the metallurgy of gold, chronicled during 1918,[10] referred to the recognition of charcoal as a precipitant, and its resurrection from the obscurity to which it had been assigned for many years. This was achieved by the adoption of a new method of application, which has insured success. Briefly stated, it was found by the investigators that precipitation efficiency increased with fine grinding. The precipitant was therefore slimed in a ball mill, and formed into cakes on the leaves of a miniature filter of the Butters type, through which the pregnant solution was sucked by vacuum. In several instances the installation of the new method, in place of a zinc-precipitation process, resulted in an improved extraction of gold from the solution, together with reduced operating costs. Its wide application is doubted, as, up to the present, it has been found unsuitable as a precipitant for silver. It is probable, however, that further investigation may indicate the feasibility of using it prior to zinc or aluminum precipitation, or as a substitute for either, in the case of silver-gold or gold-silver ores.

Renewed interest in charcoal as a commercial precipitant resulted in a focusing of attention on the question of the theory of the process. Since the results of Morris Green's experiment, and his deductions thereon, were published in 1912, practically all contributions to the literature of the subject have been in support of the theory that the abstraction of gold was the result of a chemical action between the occluded carbon monoxide gas and the gold-potassium-cyanide solution. More recently[11] attention has been directed to the fact that, whereas surface tension and adsorption both play such an important part in the abstraction of gases and dissolved substances by charcoal, it is reasonable to assume that the action is physical rather than chemical, especially because a definite parallelism may be traced between many of the characteristic features of the so-called "precipitation" of gold by charcoal and other results that are admittedly due to adsorption.

Gold Extraction With Colloidal Carbon

Perennial interest is displayed in the possibility of abstracting the gold which occurs in minute quantities in sea water; but all schemes to this end have been classed with the numerous suggestions for the insuring of perpetual motion without external influence or aid, and other "woolly" ideas.

A recent patent was allowed to which a certain amount of scientific, if not commercial, interest may be attached. It is proposed to attempt the extraction of gold from extremely dilute solutions, such as sea water, by means of treatment with colloidal carbon. Assuming that the action is one of adsorption, and that there would be a selective preference for the gold compound rather than for the other salts in solution, the idea might have a wider application.

Investigation into the question of the effect of the interaction of aurocyanide solution and colloidal carbon was proposed some years ago, but nothing further was heard of the subject until it was suggested that the excellent results being obtained in the new Moore-Edmands process were partly due to the fact that some of the ground charcoal used was in the colloidal condition. This would suggest colloidity by subdivision, and is no adequate explanation of the fact that precipitating power regularly increases as reduction in the particle size of the precipitant increases, although it is feasible to infer that colloidal carbon may be released by comminution.

Aluminum and Zinc Precipitation

The high price of aluminum has resulted in decreased attention being paid to the substitution of this metal for zinc as a precipitant. In one case[12], however, the change has been reported to have been followed by a marked saving in cyanide and lime. The only trouble experienced was due to an accumulation of calcium aluminate in the piping; and improvements are being made to prevent or decrease this. A further reduction in the amount of dust used is anticipated. Aluminum is also being used in place of zinc at the plant of the Cia Beneficiadora de Pachuca, Mexico, and considerable economies are being effected.

Apart from the introduction of de-aërating apparatus at several plants, no change is to be noted in zinc-dust practice, although attention has been drawn[13] to alternative methods of estimation of the purity of the product usually used.

A modification of normal practice is to be noted at the McIntyre Porcupine plant, where it has been decided to install the Miller chlorine process in order to produce a high-grade product, and so avoid the excessive marketing expenses associated with a comparatively low-grade bullion.

Zinc-shavings precipitation practice has progressed little, but is still widely adopted. Attention has been paid to the various refinements of operation which have been introduced during several years of progress; but it is to be regretted that prominence is still given to types of apparatus which have aided in bringing the process into disrepute. The practice of adding lump cyanide at the head of the box, in an effort to counteract the inertness of the solution met with in many close-circuit plants, is being more extensively discouraged, and, as a result, economies of both cyanide and zinc are usually achieved. A shortage of acetate of lead in one instance resulted in the local manufacture of lead nitrate by dissolving litharge in nitric acid[14].

Refining Gold Bullion

In view of the baseness of the bullion obtained by certain methods of cyanide treatment and zinc precipitation, it is of interest to note that a modification of Miller's chlorine process was evolved[15] in 1918. In commenting on the refining of gold bullion, the author draws attention to the fact that the major losses of the precious metal occur during the final stages of the process. The refining "end point" is determined by allowing the escaping fumes to condense on a piece of cold clay pipe. When a yellow color is obtained, in-

[10] H. R. Edmands, *Trans.* I. M. M., 1918.
[11] A. W. Allen, *Chem. and Met. Eng.*, June 15, 1918, p. 642.
[12] Annual Report of New York & Honduras Rosario Mining Co., 1917.
[13] L. A. Wilson, *Eng. and Min. Journ.*, Aug. 24, 1918, p. 334; and J. E. Clennell, *Eng. and Min. Journ.*, Oct. 12, 1918, p. 672.
[14] "The Supply of Lead Salts for Use in Cyanide Plants," by Thomas B. Stevens, *Journ.* Chamber of Mines of Western Australia, May, 1918, p. 117.
[15] "Refining Gold Bullion With Chlorine Gas and Air," by R. R. Kahan, *Trans.* I. M. M., 1918.

dicating the escape of gold chloride, the process is considered complete. The difficulty in the Miller process has been to remove, without unnecessary loss of gold, the last traces of base metals.

The alternative method suggested combines the principal features of the Miller process with Rose's method of toughening gold bullion by means of oxygen or air. Two clay pipe stems are introduced into the refining crucible. One is connected to an air compressor delivering air at a pressure of 6 or 7 lb. per sq.in. and the other to a chlorine generator. Maximum air and minimum chlorine are used during the initial stages of refining, the amount of air is gradually reduced to nil, and the air pipe is then removed and chlorine used alone. The advantages in the modified process are seen in reduced losses of gold and a shortening of time required to effect the purpose. It is also noted that the most refractory bullion absorbs chlorine with avidity after having been treated by the combination method.

Sodium Sulphide in Cyaniding

An interesting development in the metallurgy of gold has taken place in connection with the cyanidation of the quartz ore at Prestea mine, Gold Coast Colony, West Africa[16]. The deposit is crossed with seams of carbonaceous schist, which is also found in close proximity to the vein; and, during cyaniding operations, some of the gold is prematurely precipitated on the graphite. This resulted in high residues; but subsequent experimentation indicated the feasibility of using sodium sulphide as a corrective in a later stage of treatment.

As practiced at the Prestea, the new modification consists of drainage, after cyanide treatment in leaching vats, and re-treatment with 0.2% sodium sulphide solution. The material is then water washed, and the residue discharged. The gold-sodium sulphide solution is passed through copper shavings, where the precious metal is deposited, and receptacles similar to ordinary zinc boxes are used. The gold precipitate is filter-pressed, dried and smelted. Copper-gold bullion, matte, and slag result, which assay 100 fine, 33 oz. per ton, and 12 oz. per ton, respectively. The new process recovers an additional 50 cents' worth of gold per ton of sand treated.

With regard to the theory of this interesting development, it has been proposed[17] that the sulphide was a solvent for the gold precipitated on the carbon. More recently a hypothesis has been advanced[18] which draws attention to the evidence in favor of the theory that a gold solution is adsorbed by the carbon rather than chemically acted upon by occluded gas, and that the addition of sulphide introduces new factors of surface-tension influence, with the result that a part of the adsorbed gold compound is released and is available for treatment with a precipitant.

A comparatively recent modification in connection with the precipitation of gold and silver received publicity in 1918. A brief account of T. B. Crowe's experiments and the practical results achieved by deoxidizing cyanide solutions by means of a vacuum, prior to zinc-dust precipitation, was published[19], but few details were given. The new system was used throughout 1917, and results for six months' operation were given in the paper which was read at the September, 1918, meeting of the Institute at Colorado. It is to be noted that considerable savings have been effected in the consumption of zinc dust and cyanide.

Mr. Crowe's explanation of the theory of the reactions involved assumes that nascent hydrogen is the active precipitating agent, and that its combination with oxygen in the solution reduces the precipitating efficiency. This view is opposed by O. P. Watts,[20] who draws attention to the fact that the dissolving of zinc in a solution of pure sodium cyanide is an example of the displacement of one element by another; and that, when zinc is immersed in a dilute cyanide solution containing gold, two reactions occur simultaneously—some of the zinc is dissolved by the double cyanide of gold with precipitation of the precious metal, and a portion of the zinc dissolves in the sodium cyanide, forming hydrogen.

The distinctive feature of the new modification is undoubtedly the saving of zinc and cyanide resulting from the feasibility of abolishing the practice of adding lump cyanide at the head of the presses. In this connection it is interesting to note that the Crowe modification is a radical departure from the practice, so often found beneficial in improving precipitating efficiency with zinc-shaving precipitation, of *oxidizing* the solution, before it reached the boxes, by treatment with air. The purpose was doubtless to accelerate action by insuring the prompt removal of occluded hydrogen from the surface of the zinc shavings, and so exposing fresh areas of the precipitant. Such a method would be unlikely to insure any economy in the consumption of either zinc or cyanide, although improved precipitation results were often obvious.

The theory that the presence of oxygen assists in depolarization is questioned by H. A. White, who has contributed[21] a new method for the estimation of this element in cyanide solutions. Typical analyses of solution in a Rand zinc box showed that there was little precipitation of gold in the first compartment, although the percentage of oxygen in the solution was high. In this instance, however, other factors are to be taken into consideration. The first compartment of the box may contain the bulk of the white precipitate common in that district, so that vigorous action would be unlikely in any case. The white precipitate is found when free cyanide content is low, and it would be interesting to know whether its formation could be prevented by means of a preliminary deoxidizing of the solution.

The whole subject of the reactions involved during the precipitation of gold in aurocyanide solution by zinc shavings or dust constitutes a field for investigation, particularly in relation to the interfering or helpful influence of oxygen. Comparative figures will doubtless be available at a later date, and a more complete hypothesis may be suggested to account for the results.

Apart from theories as to the cause of the abstraction of gold from an aurocyanide solution by charcoal,

[16] "The Sodium Sulphide Process of Gold Recovery," by F. Wartenweiler, *Trans.* I. M. M., 1918.

[17] "The Precipitating Action of Carbon in Contact With Auriferous Cyanide Solutions," by W. R. Feldtmann, *Trans.* I. M. M., Vol. 24, p. 329.

[18] "Charcoal Precipitation of Aurocyanide," by A. W. Allen, *Met. and Chem. Eng.*, June 15, 1918, p. 644.

[19] *Trans.* A. I. M. E., 1918.

[20] *Chem. and Met. Eng.*, Nov. 1, 1918, p. 652.

[21] "The Estimation of Oxygen in Working Cyanide Solutions," *Journ.* Chem. Met. & Min. Soc. of S. Africa, June, 1918, p. 292.

and the proposals as to the actual reactions occurring during precipitation, little advance in the chemistry of the process can be recorded. White's method[22] for the estimation of oxygen provides an apparently reliable system of testing, which it is hoped will lead to the publication of data of interest.

The new method is based on the fact that the addition of alkali to many photographic developers causes a darkening of color, due to the formation of quinones; and the use of alkaline pyrogallol to absorb oxygen is one of the standard methods of gas analysis. Experimentation has shown that there is a close connection between the color developed and the amount of oxygen in the solution. Standard color flasks are prepared for comparison, and a 250-c.c. sample of the cyanide solution is treated with 0.100 gm. pyrogallol and 1 c.c. of twice-normal NaOH. By comparing the coloration produced with the standards, the amount of oxygen may be estimated within 0.5 mg. per liter.

Gravity Leaching Practice With Gold Ores

The leaching of gold ores in open vats is still one of the major methods of metallurgical treatment, but there is no technological progress to report. Copper metallurgists have adopted the method extensively, and installations like the Ajo leaching plant of the New Cornelia Copper Co. indicate that the last word had not been said as to improved and economical leaching practice. The principle involved is often the same with both metals, though conditions differ. The applicability of leaching to gold ores is extensive, but there has been an inclination in some quarters to consider the method out of date, and to reserve research and improvement for other and more complicated processes, which necessitated more frequent readjustments to the varying conditions encountered. Hence the neglect of leaching.

The opportunity remains. There is no question as to the comparative cheapness per ton capacity of a large leaching plant, as compared with the equipment necessary for any other wet-chemical method. The resulting low cost of operation would be an added incentive to the inclusion of a large tonnage of gold-ore reserves, now considered as unprofitable because of the expense of reduction to slime, the difficulty of entirely isolating, for precipitating purposes, dissolved gold associated with slime, and the high cost per ton when operations are carried out on a small basis.

It is interesting to note that during 1918 experienced expressions of opinion[23] in favor of leaching treatment for gold ores have been in evidence. A few years ago the logic of such views would have been questioned. It would have been recalled that leaching was the first system adopted on a working scale to recover gold from cyanide solutions, and that new methods should receive greater attention. Such a line of argument was favorably received by many engineers. In spite of this, however, it is interesting to note that the bulk of the gold recovered by the cyanide process is still obtained by leaching. In view of its general applicability to all classes of simple gold ores, I predict that it will survive so long as cyaniding is in practice.

Attention has been drawn to the neglect to realize that the economic leaching of gold ores involves comminution according to requirements. Certain ores will leach satisfactorily when crushed to ¼ in., or even larger, but, where the gangue is hard and the gold finely disseminated, fine crushing is imperative. The scope of leaching is little understood. A very fine sand, passing an 80-mesh screen, will often leach satisfactorily, and can be treated with only a fraction of the expense involved if sliming is practiced. It is certainly too common for metallurgists to attempt experimental leaching on, say, 20-mesh material; and then, because the results are unsatisfactory, as they almost invariably will be, go to the other extreme and finally affirm that sliming to 200-mesh is the only solution of the difficulty. Had this last-mentioned policy been adopted more extensively, it is probable that many, instead of comparatively few, gold properties would have failed to pass the recent crisis without suspension of operations, and would have been obliged to close down, at least temporarily, on account of the high cost of treatment. As matters stand it is probable that greater attention will be paid to the refinements of leaching practice as applied to the metallurgy of gold, in the near future, in an effort to solve the problem of the treatment of low-grade deposits, even as the copper metallurgists have done, although, of course, on a smaller scale.

The features of successful practice needing emphasis are (1) the feasibility, in many instances, of treating by gravity leaching a large proportion if not all the slime produced; (2) upward percolation; (3) countercurrent enrichment of solution and the avoidance of unnecessary precipitation; (4) degree of grinding and depth of charge to insure (a) avoidance of slime being washed through the crevices between adjacent coarse particles, (b) normal percolation rate, and (c) satisfactory extraction of the metal; and (5) the ability to distribute homogeneously a leaching charge after dry crushing or dry crushing and roasting. The practicability of the amalgamation of leaching plant residues has received little or no attention.

Magnesium

Four producers of magnesium in the United States in 1916 made 75,400 lb., valued at $311,570. Production of magnesium, according to the U. S. Geological Survey's report, was 116,938 lb. during the first six months of 1918. This amount exceeded that of the entire year 1917. War needs and the increasing use of light alloys absorbed the increased production. The average price fell from $4.13 per lb. in 1916 to $2.10 per lb. in 1917. The price early in 1916 reached $5 per lb. Late in 1917 it fell to $1.85 per lb. The price at the end of 1918 was $2 per lb. for lots less than 1000 lb., and $1.85 per lb. for lots greater than 1000 pounds.

In 1916 magnesium was made by the Electric Reduction Co., Washington, Penn.; Norton Laboratories (Inc.), Lockport, N. Y.; Rumford Metal Co., Rumford, Me.; and General Electric Co., Schenectady, N. Y. The American Magnesium Corporation, the successor of the Aviation Materials Co. at Niagara Falls, made an output in 1917, and the Dow Chemical Co. began production at Midland, Mich., but was prevented from operating at its full capacity by shortage of coal. The General Electric Co. closed its plant in 1917.

[22] Ibid.

[23] E.g. A. L. Blomfield and J. M. Trott in a paper on Cripple Creek ore treatment, *Trans.* A. I. M. E., 1918.

The Flotation Process

By A. W. ALLEN

THE litigation over the basic flotation patents reached another stage during 1918, but, to appreciate the most important finding of that year, it will, perhaps, not be out of place briefly to recall the gist of the Bourquin decision, given in the U. S. District Court of Montana on Aug. 25, 1917. This decision was in favor of Minerals Separation, Ltd., and led to an appeal being lodged by the defendant—the Butte and Superior Mining Co. The decision supported the claim of the plaintiff company that oil used in excess of 1% was inert and valueless, the judge making a sharp line of demarcation between what he considered effective and non-effective oils. The result was an opinion which stated that the defendant company could not escape the charge of infringement of the patent by the addition of non-effective oils to make the total amount in use more than 1%. This decision was reviewed by the U. S. Court of Appeals for the Ninth Circuit at San Francisco, which, on May 13, 1918, filed a decision reversing the Bourquin verdict. There was, apparently, no dissension among the judges in their refusal to recognize the distinction between effective and non-effective oils, an experimental showing by a Minerals Separation engineer at the hearing having failed to convince them that the so-called non-effective oils were inert so far as froth formation was concerned. The decision hinged a good deal on the interpretation of the phrase "a fraction of 1%," and the San Francisco judges appear to have concluded that this is equivalent to less than 0.5 per cent.

This decision will be reviewed by the highest tribunal in the country—the Supreme Court. Minerals Separation, Ltd., claims that two findings in the Supreme Court decision in the Hyde case (where it was contended that the process involved violent agitation and the use of less than 1% of oil, and that a more or less permanent froth resulted) were misinterpreted in the most recent decision. It disclaims the limitation of the patent to the use of 0.5% of oil or oily substance, or its extension to any oil or oily substance having preferential affinity for metalliferous matter over gangue; and contends that the scope of the patent must be considered only in connection with specified results. The last-named view would exclude from consideration all classes of oil which are different from those with which the most satisfactory result can be obtained.

In the Hyde case it was shown that the flotation was effective only when the proportion of oil used fell below 1%—to one-third or one-half. Hence the San Francisco decision. The Supreme Court will be called upon to define precisely the phrase "a fraction of 1%," and at the same time to give an opinion on the decision as to whether or not a patent is infringed when the literal interpretation of its specifications is evaded and where inferior results are obtained by the evasion.

The most recent action of interest was taken by the Federal Trade Commission, on Nov. 16, 1918, when it issued a formal complaint against the various Minerals Separation companies, impugning, by inference, pro-German proclivities, and contending that the companies' attitude toward clients was unjust, and that the terms under which licenses were issued were unjustifiably harsh.

A lull occurred during the period under review with regard to suppositions as to who practiced flotation first, and where. Attention was, however, drawn to the fact that the natives of Brazil had been in the habit of using the juice obtained from certain herbs which they mixed with the water used in washing and panning auriferous ground. It was suggested[1] that the practice forestalled the invention of flotation as applied to the extraction of metals. This view was shown to be erroneous[2] and the action was explained by the fact that gold tends to flour when fine, and that the addition of the extract was for the purpose of neutralizing the infinitesimal quantity of oil or grease present on the gold and so permit it to be be wetted, and thus to sink. The effect was, therefore, the opposite to that desired in flotation work.

New Flotation Machines

Two different types of flotation apparatus came into prominence in 1918. The Groch and Ruth machines are in one category and have much in common. The former consists essentially of a number of impellers operating in a V-shaped box 14 ft. long by 5 ft. wide, divided both longitudinally and transversely into compartments.[3] The impeller operates in the manner of a pair of centrifugal pump runners, air and oil entering the top section through a vertical hollow shaft, and pulp entering the lower section through a short intake. There is a common horizontal discharge of mixed oil, air, and pulp from the impeller. In the Ruth machine[4] the oil and air also enter through a hollow vertical shaft, but are discharged, through four hooded ports, from the upper surface of the distributor. Simultaneously the pulp is drawn with the distributor from below, and is discharged through four ports, also on the upper surface of the distributor, which are unconnected in any way with the air ports. The feature of the machine is, therefore, that the pulp and air are mixed as they emerge from the distributor by a method which tends to throw the product upward. Counter currents are thus minimized.

The Hynes machine has been used successfully on the silver-gold ores of Guanajuato. It consists of a suitable trough in which a number of perforated disks, 30 in. in diameter and spaced 1¼ in. apart, are attached to a horizontal shaft, which is caused to rotate at a speed of about 100 r.p.m. Only the lower portions of the disks are submerged, so that air in the perforations is carried down into the pulp, and this, together with the actual movement of the disks, causes agitation and facilitates intimate contact between mineral and oil.

Excellent work was done in the Guanajuato district of Mexico during 1918 in determining the suitability of

[1]Kirby Thomas, *Met. and Chem. Eng.*, June 1, 1918.
[2]E. Jordan, *Chem. and Met. Eng.*, Nov. 1, 1918.
[3]F. O. Groch and W. E. Simpson, *Trans.* Can. Min. Inst., 1918.
[4]"The Ruth Flotation Machine," by J. P. Ruth, Jr., *Eng. and Min. Journ.*, Apr. 20, 1918, p. 752.

flotation as a method for the extraction of a concentrated product from silver-gold ores. At the Cubo company's property there considerable success was achieved by the treatment of freshly broken crushed ore in Hynes flotation machines. Important data were secured, and it was found that the extraction of gold was above expectations, and that the newer process was unsuitable for the treatment of material from old fills. The ratio of gold to silver is high in this particular instance, and the average extraction of both metals in concentrate form, by flotation, is consequently higher than the average recovery by cyanidation. The differentiation between the two products obtainable by these rival processes is pertinent, as the advantage of securing a final output as bullion is obvious, and this is a feature which detracts from the popularity of flotation. The silver extraction by flotation appears to have been lower than the recovery by cyanidation. Flotation was used entirely by the Cubo company, and the concentrate produced was shipped to the Aguas Calientes smeltery of the American Smelting and Refining Co. At the plant of the Guanajuato Consolidated Mining and Milling Co. six Jones-Belmont flotation machines were in successful operation, and the concentrate was cyanided on the property.

Flotation of Silver Ores in Canada

Flotation at Cobalt, Ontario, Canada, passed the experimental stage in 1918, and published results[6] show that it has almost completely displaced gravity concentration. Various questions of comparative economy have arisen, and in some instances it was considered preferable to sacrifice extraction to insure a high-grade concentrate, and so evade high marketing expenses. The majority of the producers depend on United States smelteries to absorb their products, but charges have been excessive. At the Nipissing Mines plant, however, the difficulties encountered in treating the concentrate successfully, coupled with the alternative expense of shipping it, led to the abolition of flotation early in 1918, and the reinstatement of the practice of gravity concentration, followed by cyanidation of the product.

Little progress was made in the flotation of gold ores during the year, and the newer but less complete process is now considered unlikely to become a serious rival to established methods of treatment. The major tonnage of gold ores is treated by a leaching process, and the substitution of flotation would probably necessitate additional reduction plant to insure a finer product than is now economically practicable. There is, however, a possibility for the introduction of flotation for the concentration of the residues from some cyanide mills treating gold ore, in the same manner as has been found beneficial in Canada. In the few instances where the tailings from amalgamation plants are too refractory for cyanide treatment it has been shown that flotation may be adopted with a fair chance of success.

Progress in Selective Flotation

Advance in the practice of selective flotation in 1918 was chiefly concerned with the separation of lead from zinc. Accounts of standard practice where oils are used has been published;[6] and a detailed account of the Bradford process in use at Broken Hill[7] contains much information as to this somewhat novel and certainly successful process.

In the Bradford system no oil is used. The material treated consists of accumulated and current zinc-lead slime. This is pulped, acidified, and treated with sodium hyposulphite. Mixing then intervenes to insure ample time of contact between the SO_2 liberated from the hyposulphite, and the zinc sulphide. Ideal conditions are as follows: Acidity, 0.025 to 0.03%; temperature, 85 to 90° F.; density, 23 to 26% solid, by weight.

Agitators of special design are used and are connected with sulphur burners by means of which a supply of air and SO_2 is insured. The agitators deliver to separation boxes, where the lead sulphide floats, forming a deep froth. The concentrate is subsequently filter pressed in an apparatus of the Dehne type. The zinc middling from the separation boxes is dewatered, and acid added and heat applied. The pulp is agitated with centrifugal pumps and subsequently treated in separation boxes similar to those in the lead section. A deep froth is obtained, which is mixed, diluted, and refloated, as in the first zinc section.

Small-scale tests indicate the feasibility of re-sulphidizing the oxidized lead now passing out with the tailing, and recovering this, together with the silver. A plant is being designed along these lines, and it is expected that the assay of the residue will be reduced to about 1% lead and 1 oz. silver per ton.

In the Terry process[8] advantage is taken of the fact that ammonia in solution promotes oxidation of certain sulphides. A closed tank and a circulating system are suggested as suitable.

Development of Galena Flotation

An example of a successful change from gravity concentration to flotation is shown[9] by the result of operations at the Central Mine, Broken Hill, New South Wales, where the flow sheet has been gradually modified, stage by stage, and where the elimination of 54 gravity concentration tables and vanners has been brought about by introducing the more modern system. The change has resulted in an additional extraction of 8% of the lead and 15% of the silver content of the ore. These results have been achieved by the installation and operation of a galena flotation plant, which consists of a series of boxes set one above the other and in which the pulp, in descending from box to box, passes through nozzles by which the necessary air is added. The concentrate overflows the lip of each box, and the tailing passes on to the next in series. A small quantity, about 2 oz. per ton, of a mixture of coal tar and eucalyptus oil is added to the pulp to assist flotation.

The material handled by the new unit is the tailing from jigs (which produce a lead concentrate) and which is ground to 40 mesh before reaching the cascade machines. After treatment in the "lead cascades," as the new addition to the plant is called, the tailing is de-

[6]Excerpted from 26th Annual Report of the Ontario Bureau of Mines.

[6]E.g., C. T. Rice, *Eng. and Min. Journ.*, Sept. 14, 1918, p. 482; and *Eng. and Min. Journ.*, Sept. 21, 1918, p. 528.

[7]"The Bradford Process at Broken Hill," by E. T. Henderson, *Min. and Sci. Press*, Sept. 28, 1918, p. 407.

[8]U. S. Patent 1,254,173 of Jan. 22, 1918, to Joseph Terry, Jr.

[9]"The Development of Galena Flotation at the Central Mine, Broken Hill." By R. J. Harvey, *Trans.* I. M. M., 1918.

watered and passes to the selective plant, where the pulp is treated in flotation boxes equipped with stirrers driven from below and operated on the sub-aëration system. Lead concentrate is produced, and the tailing passes to the zinc plant, where a lead-zinc concentrate is obtained, presumably by flotation. A final separation into zinc and lead products is made by means of Wilfley concentrating tables.

Combination Treatment Often Applicable

The fact that a combination of two or more processes is often preferable to a strict adherence to the latest evolution in modern practice is obvious in many instances. An interesting example of triple concentration was described[10] during 1918 in connection with an installation where table, flotation, and magnetic concentration are practiced in one plant. Mechanically operated concentrators—jigs, Wilfley tables, and Frue vanners—produce a high-grade tin-wolfram-lead concentrate, which is handled in an M. S. flotation machine. The leady concentrate is floated off for re-treatment, and the tin-wolfram product handled by magnetic separator. A Berdan pan is used for regrinding, and the flotation unit gives an extraction, in concentrate form, of 98% of the lead.

Flotation in the Graphite Industry

Particular interest attaches to the rapid acceptance of flotation, among graphite producers, as the best process to adopt. A number of new plants were erected in 1918, particularly in the Southern States, and there was opportunity to take advantage of recent invention. Modern flotation apparatus, including such recent innovations as the Lowden drier, has been successfully adopted in this important industry. In a number of instances a mixture of clay and graphite slime, previously run to waste, is now being economically treated by the newer process.

Among recent patents is one flotation device[11] that has been designed primarily for graphite ore treatment. The principle involves the impinging of a fluid jet, free from ore, upon a pulp surface containing ground ore and suitable contaminants. A number of jets are used in each machine, and these entrain air into the liquid, causing the formation of a froth carrying the graphite, which is finally recovered in the usual way. There is a continuous flow of ore pulp into each machine, and a continuous discharge of tailing and flotation concentrate. The water pressure may vary from 2 to 200 lb. per sq.in.; and the entrainment of air is said to be accompanied by static electrical effects which may tend to accelerate separation.

The Influence of Colloids on Flotation

In many metallurgical processes colloids have received more than their fair share of blame for the uncertain and unsatisfactory nature of results. Failure to explain adequately why flotation operates successfully in some instances has been followed by frequent attempts to account for the reason why it does not work in others.

It is unfortunate that a haze has been allowed to envelop the question of colloidity by the confusion which followed the partial acceptance of the particulate theory, which aims to explain that colloidity is merely a state of subdivision. Experience, however, indicates in many instances that there is a marked difference between mechanically subdivided matter and colloidal matter, which it is impossible to consider as wholly due to particle size. Mechanical reduction to a slime inevitably produces a proportion of material which is infinitesimally fine. This can be separated by hydraulic methods, but cannot be made to give the true reactions of a colloid.

The pendulum has swung too far; and the diversion of attention from the particulate theory might well be explained as a needed reaction to discourage the inclusion of too many finely divided substances into the colloid category. The peculiar characteristic of a colloid is that it is colloidal, or glue-like. The originator of the term probably realized the necessity of adopting a synonym that indicated, by its very derivation, the distinction which must, of necessity, be recognized between colloids and non-colloidal subdivided matter.

Of late years, however, there has been an inclination to disregard the line of demarcation, and less attention has been paid to the physical peculiarities of colloids. The fluidity of water is greatly decreased by the inclusion of a true colloid, such as weathered plastic clay. It is, however, not appreciably altered by the addition of many of the so-called colloidal metals. It would seem reasonable to infer that viscosity or fluidity should be one of the factors in determining colloidity.

Keeping the idea of the probability of undue reference to colloidity in mind, it is important to note that several contributions of interest were published in 1918, dealing with the physical aspects of flotation. Judging from the majority of them, there seems to be a general opinion that colloidal matter is a nuisance in flotation work, as in other metallurgical processes.

Separate Treatment of Colloids

In one contribution[12] it is suggested that separate treatment of sand and slime by flotation merits wider consideration in those instances where it might be found to be applicable. In cases where a variety of ores are being floated, the advisability of separate treatment will be obvious, especially where the amount of ore at each crushing is so small, comparatively speaking, that exhaustive preliminary experimental work would be impracticable. In the same paper the author draws attention to the advisability of eliminating and discarding colloidal matter where practicable. Slime may carry as much metal or more metal than the original ore, but, when considering the ground product as being made up of two parts of different physical characteristics, it is often more economical to classify and discard the untreatable slime, and recover only from the remainder, than to attempt to treat the original mixture and recover practically nothing. A further point brought out is that a certain definite degree of comminution is needed to liberate the colloidal matter forming a part of an ore. In one instance reported it was found that mechanical separation of slime, after

[10] "Triple Concentration Practice for Tin-Wolfram-Lead Ore," *Eng. and Min. Journ.*, Sept. 21, 1918, p. 530.

[11] U. S. Patent No. 1,282,730, Oct. 29, 1918, to W. O. Arzinger.

[12] "Colloids in Flotation." By Jackson A. Pearce. *Min. and Sci. Press*, Oct. 12, 1918, p. 491.

the ore was crushed to 3½ mesh, was so imperfect that subsequent flotation results were poor. This was remedied by separating, after crushing to 16 mesh.

Colloids and Adsorption

The advent of the flotation process has given a new and vigorous lease of life to the term "adsorption"; and the catholicity of interpretation is now the cause of some confusion. A recent publication[13] on colloids and flotation begins with the premise that "few attempt have been made to explain the theoretical side of the process," and, to remedy this alleged deficiency, a number of hypotheses are advanced based on the contention that wetting and adsorption are analogous phenomena. The adsorption of pure water, or air, or oil, or gas, by sulphide particles, and the adsorption of finely divided substances, or oils, or compounds in solution by colloids, offers a field for an immense amount of conjecture to those able to invest a phenomenon, generally conceded as resulting in a change of surface concentration, with such characteristics.

Dewatering and Drying Flotation Concentrate

The preparation of flotation concentrates for shipment is not an unimportant phase of the process, although one which is often neglected. Considerable improvements have been made in individual plants, and the revolving-drum type of vacuum filter has been widely adopted for the dewatering of the thickened concentrate. The difficulties in the way of satisfactorily handling colloidal material are as much in evidence with flotation work as they are in any other process. Various methods to minimize trouble from this cause have been adopted, including the building up of a bed of fine table concentrate on the filter drum before putting on the froth concentrate, as described by C. T. Rice.[14] The scraper is then set so that it does not take the cake off closely, the retained bed of fine concentrate acting as a sand filter to catch the froth concentrate before it can be sucked into the cloth.

The drying of flotation concentrate was a problem until the introduction of a mechanical drier in which the material as it progresses along a series of hearth plates is chopped by the downward action of the rabbles, and leaves the machine in an ideal condition for shipment and smeltery treatment. This apparatus, which is known as the Lowden drier, was proved at the plant of the Federal Lead Co.; and all the large Flat River installations, as well as several in other districts, are now equipped with these machines. Its wide applicability in handling flotation products is shown by the fact that the machine was adopted in 1918 to handle gold ore concentrate at Cripple Creek and silver-ore concentrate at Guanajuato, Mexico.

[13] "Colloids and Flotation," Technical Paper 200, U. S. Bureau of Mines.

[14] *Eng. and Min. Journ.*, Nov. 23, 1918, p. 899.

Notes on Ore Dressing

By A. W. ALLEN

THERE were no developments in the practice of primary crushing in 1918, but results in more than one instance demonstrated the ultimate economy of obtaining the maximum reduction in a simple machine such as the average rock breaker, where power consumption is more or less in proportion to the crushing performed, and where the power consumption "running light" is small or negligible.

The stamp mill, as a unit in any new installations, is a thing of the past, although Rand practice is still uniform in this respect. No progress has been made with heavy stamps in the United States, and considerable difficulty would be experienced in supplanting the ball mill with any less fool-proof competitor. Greater attention has been paid to the screening of ore before crushing, and, to this end, shaking grizzlys are becoming more widely adopted, and a miniature trommel has, in some instances, been interposed between stamp-mill feeder and mortar box to insure the elimination of fines, and so increase crushing duty.

The Efficiency of Tube Mills

The delay in discharge of ground particles in any type of trunnion-discharge ball or pebble mill is becoming better realized, and the tendency is to reduce the length to the minimum. Ample feed and prompt discharge are considered essential, and efficient outside classification is a feature of good practice.

Individual prejudices and leanings in different districts are generally responsible for the type of liners adopted. No new design has been reported; but the experience gained in ferro-alloy work in 1918 should be of value in determining the most suitable material for future needs in this direction. A certain amount of local stone has been used for the manufacture of silex liners, but steel is generally considered far preferable.

Tube-Mill Pebbles and Steel Balls

Some progress was made in 1918 in the matter of the manufacture of small steel balls to take the place of pebbles. The elimination of practically all hand labor, which, however, is still necessary in the case of the larger balls, should result in a cheapening of production and a greater ability to compete with stone grinding media.

Attention has been drawn[1] to the feasibility of using local stone rather than imported or transported flint pebbles, and comparative data given to illustrate the frequent superiority of an available but common stone over an imported flint. The factors concerned are toughness and hardness, and these may be estimated with comparative facility by means of standard apparatus.

The laws of Kick and Rittinger seem equally popular, and are used and quoted with general impartiality. As long as each exponent keeps to the one system, which is highly probable, there is likely to be little confusion. But results would be of greater comparative value if a general agreement were reached.

A distinct step in advance has been made by Luther

[1] "Artificial Pebbles for Tube Milling." By A. W. Allen, *Eng. and Min. Journ.*, June 8, 1918, p. 1038.

W. Lennox, whose interesting paper,[2] describing a method of determining the comparative friability of ores, will suggest a simple system of eliciting facts which will materially influence the design of crushing plants and will aid in the work of forecasting, with greater accuracy than is possible at present, the equipment necessary.

Progress in Ball-Milling Practice

Advance in ball-milling practice has centered in a wider recognition of the merits of outside classification and closed-circuit operation. In addition, large-scale results tend to show[3] that it is not good practice to ignore the efficiency of a crusher for primary reduction and expect results from a ball mill fed with too coarse a product. This has led to even greater attention being paid to classifying and screening devices, and to a closer control of adjustment based on calculation of efficiency of operation. A sizing analysis without any information as to tonnage to which it refers is valueless when two or more products are being made. An exact calculation from a formula shows the precise efficiency of separation; and it is only after this is obtained that logical steps can be taken to improve results where improvement is possible.

The reports of a large number of experimental tests and the publication[4] of discussions and personal opinions have resulted in a better understanding of the situation and the elimination of many prejudices and generally accepted though unsound theories.

Future improvement in ball milling will be concerned chiefly with the prevention of sliming in those cases (e.g. amalgamation, gravity concentration, and flotation) where it is undesirable. Progress in metallurgy in 1918, in many instances, proved the contention that metal or mineral should not be reduced in size beyond that required to free it from the accompanying gangue. To do so is to invite an otherwise avoidable loss.

The ball mill has come to stay. Its simplicity has appealed to all concerned, but its efficiency as a machine to deliver an even grade of product without any appreciable production of fines, i.e. material passing a mesh below the necessary minimum, still leaves something to be desired. There are numerous instances where it is maintained that sliming is immaterial. There are more cases where the production of slime involves a loss in residue or an extra expense in treatment. In those instances where sliming should be avoided it is pertinent to draw attention to the fact that, whatever the rate of feed through a ball mill of ordinary design, a certain amount of material will be ground to the required size within a few inches of the feed end, in addition to an additional proportion that must, of necessity, be introduced with the feed. The discharge of the already ground material should be immediate. Further unnecessary and harmful reduction can be lessened by shortening the length of the mill, but there is no method of absolute prevention without the adoption of some scheme of positive separation, such as peripheral discharge through a screen.

In early flotation work it was often maintained that sliming the mineral resulted in no ill effects, and that a feature of the new process was that a mixed feed was most suitable. As with all innovations, a number of enthusiasts predicted that flotation would entirely displace table concentration, just as others still persist in celebrating the demise of the amalgamation process, which, in certain circles, is believed to have occurred when cyanidation was introduced. To achieve this consummation, the promiscuous sliming of ores was beneficial in both instances, reducing the efficiency of the older process to a point where it was comparatively easy to argue the superiority of the more up-to-date method. There are, however, a number metallurgists who are unwilling to share the infectious optimism that pervades the atmosphere whenever a new process is under consideration. So long as a metal or mineral can be extracted in its original state of purity, they argue that a preliminary saving should, wherever possible, be made by positive means and methods without unnecessary reduction in particle size. The logic is not unsound; it is far less so than the inference that, because a ball-mill product may be unsuitable for either amalgamation or table concentration, therefore both these phases of treatment should be abolished.

A ball mill built so that the pulp, after it can pass a punched screen, is automatically classified, and the oversize returned, is, theoretically speaking, an ideal apparatus; and improvements and simplifications in the design of the original Krupp type of ball mill may be anticipated in an effort to supply a real want.

Sizing for Concentration

The relation of ample preparation to the efficiency of concentration was discussed from two aspects during 1918. In one paper,[5] dry sizing as a means of preparing feed for concentrating apparatus is advocated. The disadvantages in such a system are well known to all engineers who have had experience with dry-crushing mills, but the fact that dusting can now be reduced to an almost inappreciable quantity with certain types of apparatus is seldom recognized. The advantages of dry sizing are seen in (1) ease of control of subsequent pulp dilution to exactly suit the requirements of the concentrating machine, and (2) the improved results obtained as a result of positive separation into sizes by means of screening. The efficiency of hydraulic classifiers is often poor, and screen separation into sizes is certain to produce more satisfactory results.

As soon as the inefficiency of many installations of classifiers is realized, there will doubtless be a reaction. Screening apparatus will then receive the attention it may be said to merit, and there will be a wider recognition of the feasibility of wet as well as dry separation by such means, although, of course, within narrower limits as regards the finer sizes. The advantages of sieve separation have been emphasized[6] in a suggestive paper on the mechanical screening of wet pulp in which attention is drawn to the unsuitability

[2] *Trans.* A. I. M. E., 1918.

[3] E.g., "Changes in Alaska Juneau Mill," *Eng. and Min. Journ.*, Aug. 24, 1918, p. 352.

[4] C. T. Van Winkle, E. H. Kennard, A. E. Wiggin, Parke Channing, and B. B. Gottsberger, *Trans.* A. I. M. E., 1918; A. Del Mar, *Eng. and Min. Journ.*, July 6, 1918, p. 14; D. H. Fairchild, and Editorial, *Eng. and Min. Journ.*, Aug. 17, 1918, p. 310; F. E. Marcy, *Eng. and Min. Journ.*, Sept. 7, 1918, p. 451; E. W. Lawler and A. Tellam, *Eng. and Min. Journ.*, Sept. 28, 1918; p. 582.

[5] "Dry Sizing as a Means of Preparing Feed for Concentration." By George V. Bland, *Eng. and Min. Journ.*, May 18, 1918. p. 908.

[6] "Mechanical Screening of Wet Pulp." By H. A. Megraw, *Eng. and Min. Journ.*, Sept. 21, 1918, p. 522.

of classifying particles according to weight, rather than size, as a preliminary to concentration, and suggesting the advisability of replacing hydraulic classifiers with screens in certain instances.

When vibratory screens were first introduced, the heavy duty required was seldom realized, with the result that there were frequent breakdowns. Standard apparatus in this direction has, however, been mechanically perfected during recent years. In proportion to screen area, the output is exceptionally high, and the separation is made by positive methods which insure 100% efficiency in all the products except the final oversize, which sometimes carries a small percentage of fines. Misapprehension exists as to the large tonnage which can be put through a modern vibratory screen equipped with a comparatively small area of screen cloth; but the fact is often overlooked that a deep bed of feed is permissible because the vibration of the screen tends to stratify the grades into layers, the coarsest coming to the surface of the bed and the finest accumulating near the screen. The high capacity of such an apparatus is partly due to the vibratory action, which tends to keep the apertures open, but it is mostly to be attributed to the stratification produced by the motion, which, in itself, results in a primary classification into sizes.

Heating Ores as a Preliminary to Reduction and Metallurgical Treatment

Interesting data have been published[7] on the results, from the mechanical point of view, of heating ore preparatory to crushing. A number of tests demonstrated that heating (to about 800° C.) makes the ore easier to crush; and that heating and quenching leads to a still greater friability. The principle is neither new nor unrecognized, but the figures given are informative. By comparing the outputs of a standard crushing machine with raw and treated material, respectively, it was found that, with three classes of Cornish tin ores, a preliminary heating and quenching treatment resulted in an increase in output varying from 65 to 313%. It was also demonstrated that the effect of heating, and still more of heating and quenching, is to yield a crushed product with a greater proportion of middle-sized particles and a smaller proportion of fine slime.

Roasting Destroys Colloidal Envelope

Roasting or heating an ore prior to crushing or grinding has seldom or never been attempted other than in the case where the elimination of some interfering element or compound was desirable. From the mechanical point of view, however, there are several features of interest. Roasted ore may be ground finer than raw ore and still be in excellent condition for leaching treatment. The heating or roasting tends to change the physical characteristics of the colloidal portion of the ore, with the result that absorption is considerably decreased, and the final displacement of dissolved metal is made with greater facility. A second advantage of roasting is the reduction in weight of material to be crushed, and the possibility of recovering a valuable byproduct from the gases evolved during the process.

[7]"Effect of Heating, and Heating and Quenching, Cornish Tin Ores Before Crushing." By Arthur Yates, *Trans.* I. M. M., 1918.

In one instance in the tests quoted there was little advantage to be seen in quenching after heating. In similar cases the preliminary heating or roasting of the ore would result in a product in ideal condition for dry crushing. In other cases where experimentation showed that quenching would result in a material increase in friability, the advantages of wet crushing would be obvious.

An important adaptation of roasting is seen in the new Caron process for the treatment of manganese-silver ores[8]. The MnO_2 is converted into MnO by means of a reducing roast in a revolving kiln, and cyanidation is then found to be economically practicable. In the case of the low-grade manganese silver ore of the Buffalo-Hunter Mining, Milling and Development Co. less than 15% of the silver can be extracted by direct cyanide treatment, though after the reducing roast the amount reaches 85 per cent.

Bismuth

By W. R. Ingalls

Most of the bismuth of the world is obtained from Bolivia, where it is produced as crude bullion, which goes to London for refining, the well-known firm of Johnson, Mathey & Co. being specialists in that. For many years, that concern, together with some German producers, had an absolute control of the world's market, and they were very dictatorial about it. In recent years a considerable quantity of bismuth has been produced in the United States as a byproduct of electrolytic lead refining. The American producers are supposed to have an understanding with Johnson, Mathey & Co., but that is only a surmise, for all parties preserve great secrecy. It is safe to say, however, that anyone who is contemplating the competitive production of bismuth should be careful as to his movements.

In general, the pyrometallurgy of bismuth is similar to the metallurgy of lead, but a great deal of skill is required in adequately refining the crude metal, and the value of refined bismuth varies greatly according to its character. The best grade of the metal is that which is used for pharmaceutical purposes, which constitutes the major consumption, and commands a price that is far superior to what is fetched by ordinary metal, suitable for making fusible alloys and for other industrial purposes.

The electrolytic lead refiners recover bismuth in their slimes when they are working up lead bullion that contains any bismuth. What is the procedure in recovering bismuth from the slimes, I do not know, nor has it been described in technical literature, but no doubt the process is more or less intricate. In brief, the essential part of the metallurgy of this metal, viz. the refining, constitutes an art that very few persons know about, and they have taken very good care to keep the knowledge to themselves.

Bismuth prices do not fluctuate greatly. During 1917, the price was $3.50 per lb. for the last half of the year; in 1918, in February and March, the price dropped to $3.35 per lb., but returned to $3.50 per lb. and held there during the remainder of the year.

[8]Communicated by Harry Wolf, consulting engineer, Denver, Colorado.

General Review of Mining in the United States In 1918

A SHORTAGE of labor, increasing wages, and high costs all around were conspicuous features of the mining situation in the United States during 1918, as they were of American industry in general. The labor scarcity was at its worst in the late autumn, owing to the universal epidemic of influenza. Before the year had closed, however, the sudden termination of the war released men to such an extent that many camps were able to obtain their desired quota. Conditions in gold mining, already bad in 1917, became worse in 1918, and, with the closing down by one company after another, the outlook for gold production was most unpromising. The situation in this regard was somewhat easier at the end of the year. Advancing smelting charges, together with the increased freight rates that became effective on June 25, put additional burdens upon producers.

The campaign to increase the production of war minerals, begun in 1917, continued with increasing effectiveness in 1918, imports still being restricted, until in the case of chromite an oversupply was discovered, and cancellation of contracts for other minerals, due to the armistice, left producers in the lurch. The War-Minerals Act, signed on Oct. 5 after prolonged discussion, was intended to stimulate production, but proved needless. Up to the end of 1918, financial aid for those who had engaged in producing such minerals did not appear possible under the act.

ARIZONA

The copper situation in Arizona throughout 1918 is the subject of a separate article appearing elsewhere in this issue. The various camps throughout the state operated steadily, being virtually free from strikes during the year, in notable contrast to conditions in 1917. Only one strike of importance occurred, that in February at the Hayden plant of the American Smelting and Refining Co., and the trouble was quickly settled. Copper production increased markedly, despite the labor shortage. Thousands of skilled mechanics and miners were taken away for Government work and by the draft. However, the need for mechanics was lessened by restrictions on new construction and by the high cost of supplies. The regular influx of Mexicans in the spring was augmented by high wages and by unrest in Mexico. Many had left the United States fearing the draft. In the September registration, the matter was better understood. Influenza made inroads in the autumn, as elsewhere. At the end of the year, the gold mines of the Oatman district were reported to have their full quota, which was generally true throughout the state, due in part to the return of workers from war industries and to the annual winter migration of workmen to the southern climate.

New projects completed included the Ray Hercules mill, United Verde Extension's new smeltery at Verde, and the dry process plant of the U. S. Vanadium Development Co. The latter property was leased to the Allied Metals Co., of Denver, for 10 years. The Gold Road mines, in Mohave County, built a 300-ton crushing plant, and the Hackberry Silver Mining Co. a 200-ton concentrator and power plant. Milling plants were also erected by the Yucca Tungsten Mining Co., the McCracken Silver-Lead company and the Arizona Ore Reduction Co., all in the same county. The Standard Minerals Co., at Kingman, erected a test mill for floating molybdenite ores. The Flux and the World's Fair mines, in Santa Cruz County, also erected mills. A mill site was graded near Warren by the Copper Queen Branch of the Phelps Dodge Corporation, and much of the Sacramento Hill overburden stripped by shovels. Erection of a 500-ton experimental flotation plant was begun by the New Cornelia company.

Most of the transfers of mining property in Arizona during 1918 were by way of working bonds. The American Smelting and Refining Co. added the Sasco smeltery and the Silver Bell-Red Rock railroad to its purchase of the Imperial mines. The World's Fair group, near Patagonia, and the George Washington group, in Mohave County, changed hands. The Shannon Copper Co. took over the Yeager Canyon property at Prescott. Magma Chief acquired the Sombrero Butte holdings and closed down its operation at Superior. Ray Broken Hills Mining Co. bought the Sherlock Schillings group. Transfer of property and the increase in small stock companies, so prominent in 1916-17, were noticeably lacking. The Schuylkill Mining Co. purchased the adjoining Tennessee mine, a lead-zinc producer practically worked out. The Golconda mine, a zinc property in Mohave County, shut down. According to the U. S. Geological Survey, considerable zinc shipments came from the Duquesne property, in Santa Cruz County, and from the Hillside property, in Yavapai County.

In the latter part of 1918 there was a betterment in car supply. Economy was effected by substituting motor trucks for wagons in hauling ore to railroad points. Transportation was further improved by the construction by Ray Hercules of three miles of track to its mine and mill at Hercules, and by a railroad extension from Clarkdale to United Verde Extension's new smeltery at Verde. Work still in progress at the end of the year included a switchback road from the Verde Valley up to United Verde's old smeltery site above Jerome, also a broad-gage line to the main shaft of Verde Extension through its 12,000-ft. tunnel.

The only legislation affecting mines by the Arizona Legislature was a bill originally intended to prevent vagabondage, but amended to cover such matters as the Bisbee deportations. This became law without the Governor's signature. A memorial to Congress asked for a grant of 640 acres to discoverers of oil. A workmen's compensation act was defeated.

CALIFORNIA

Mining in California in 1918 was pursued on a wider and more varied scale than ever before. Gold

mining suffered. But the state, ranking high as a producer of tungsten, chrome, magnesite, and other war minerals, was able to respond to the great demand for them. Results were good at first, but the ending was unprofitable for many. Thirteen out of 19 companies producing magnesite in 1918 shut down before the close of the year, owing to market conditions. As for chrome, the market disappeared before the armistice was signed. Overproduction of tungsten became apparent in October, with its consequent effect upon operations.

During 1918, about 47 gold dredges were in operation, 22 of them by two companies, the Natomas Consolidated and the Consolidated Goldfields. Operations were confined principally to the American and Feather rivers. Natomas' Feather No. 2 dredge, at Oroville, shut down after 10 years' operation. The Pacific Gold Dredging Co. closed its No. 4 dredge at Oroville. A new dredge was launched at Trinity Center by the Estabrook Gold Co. La Grange hydraulic gravel mine, in Trinity County, was shut down, as was the Excelsior Gravel mine, in Placer County. Various other properties were similarly affected. A set of safety rules for gold dredges was prepared by the State Industrial Accident Commission.

The Grass Valley district was active to the end. The North Star mines operated at a small profit, with milling curtailed. In Amador County, the Fremont mine shut down. Both the Old Eureka and Central Eureka deepened their shafts, the latter taking good ore from the lower levels. The gold situation generally improved at the end of the war.

Chrome mining was active in Siskiyou and many other counties until the market changed. Steps to aid chrome production by road building were taken by the Government through the Forestry Service. Chrome on railroad land was held by the U. S. Land Office to be open to location.

The main Mammoth property, at Kennett, underwent development. The 40-stamp mill of the Keystone Copper Co. at Kennett lost only 17 hours' running time in the first six months. A large copper production was maintained by the Penn Copper Co., Calaveras County, and by the Iron Mountain and Hornet mines of the Mountain Copper Co., at Keswick. Development of the Walker mine, at Portola, was pushed, and a tunnel started from mill to mine.

The Tomboy lead-silver property was opened at Lone Pine, Inyo County. Silver mining was resumed after 20 years at the Silverado mine, in Lake County. The Crystal mine, in Shasta County, was relocated as the White Star and opened after 30 years' idleness.

Tungsten production was maintained by the Atolia company, in San Bernardino County, and by other properties. The Noble Electric company shipped manganese from the Crescent Mills region to the Heroult smeltery and also developed it in the Tesla district in Alameda County. Many other properties also produced tungsten. Pumice stone was produced in Siskiyou County, lithia ore in San Diego County. Graphite was shipped by the California Graphite Co. at Los Angeles. Quicksilver mining was active and miscellaneous other minerals were produced to some extent, particularly potash at Searles Lake.

Various properties changed hands. Anaconda acquired the Walker, at Portola, and the Pacific Gold Mines Corporation took over the Dutch-Sweeny and App properties, in the Jamestown district. Allison Ranch was operated by Grass Valley Consolidated. The Keystone Copper property, at Kennett, was sold to the U. S. S. and R. Co. A Los Angeles syndicate bought the Armada Tungsten holdings at Inyokern. The Bloomer Hill property, at Oroville, was purchased by the California National Gold Mining Co. At the end of 1918, the Idaho Maryland mine, at Grass Valley, was sold to Eastern interests. The increase in the use of motor trucks was notable.

Colorado, Utah and Idaho

Mining in Colorado, Utah and Idaho will be reviewed in detail in separate articles in the following issue. In Colorado, 1918 was unprofitable on the whole, conditions bearing extremely hard on small producers. Federal regulation was at its worst. Fixing of the silver price proved less advantageous in the end than it had seemed at first. In general, development was retarded by labor shortage, especially at Cripple Creek. The more important developments were the new Camp Bird lower crosscut tunnel; the work of the U. S. Smelting interests in the Sunnyside mine, in San Juan County; fluorspar operations in the Jamestown district; and the work on oil-shale properties near De Beque and Grand Valley. The closing down of the Leadville unit of the United States company was a blow to that district.

Mineral production in Idaho was in 1918 probably 20% less than in 1917, according to R. N. Bell, due to the same causes that affected mining elsewhere. Mines secured their labor quota after the armistice, but, owing to the uncertainty of the market, displayed a tendency to curtail production. In Utah, the tonnage and value of the output were considerably less than in 1917. There was a marked decrease in leasing, caused by the high wage rates and the cost of supplies. A tax on net proceeds of mines, levied in 1917, met solid opposition when it became payable in 1918. Western Utah Copper and Columbus Rexall entered the list of dividend payers.

Michigan, Minnesota and Wisconsin

A general review of iron mining in the United States will be found elsewhere in this issue; likewise a résumé of operations in the copper country of northern Michigan. Zinc mining in Wisconsin is also separately covered. Comparatively little prospecting was done in Wisconsin, and power shovels helped offset the labor shortage.

Missouri, Oklahoma and Kansas

Lead and zinc mining in Missouri is discussed in detail in special articles in this issue. The zinc districts of Kansas and Oklahoma are also the subject of a separate article on another page. In the latter part of 1918 the Oklahoma Ore Storage Association, at Picher, undertook the construction of warehouses for the purpose of storing zinc ores. It was planned by the organization to develop independent markets abroad for sulphide ores. In Missouri, there were few new

developments, but practically every mine in the state was in operation during 1918. Labor was scarce, as elsewhere.

MONTANA

Until the armistice, the Butte and Philipsburg districts of Montana shipped an average of 600 tons each per day of manganese ores to Eastern steel companies, namely, the Tennessee Coal, Iron and Ry. Co., Carnegie Steel, Cambria Steel, Billrowe Alloys, Burgess Minerals, National Carbon, Lavino, and Miami Metal companies. The market stopped suddenly with the armistice, causing hardship to producers and throwing about 1000 men out of work. The largest body of manganese ore developed was in the Emma mine, at Butte, which in October produced 10,000 tons. In Philipsburg, the largest producers were the Philipsburg company and the Western Ore and Mining Co., each with a monthly output of about 3000 tons. At the request of the Government, Anaconda erected a $750,000 ferromanganese plant at Great Falls, with five furnaces. Started on Oct. 15, it shut down on Dec. 6 without having sold one pound of the 1000 tons of ferro made. The undertaking of this project had given impetus to the search for manganese ores.

Mining and development work were pushed vigorously in the Butte district throughout 1918. Anaconda's High Ore mine resumed operations in January, after the shut-down due to the Modoc fire, but was later closed down to fire-proof the shaft. The Alice mine was down three months. Both properties resumed before the end of the year. Sinking was pushed at the Mountain View shafts and at the Belmont and Original mines. Butte & Superior reduced its operations 50% in December, when Anaconda suspended receipt of custom zinc ore. The Davis Daly drove the Belmont crosscut in the Colorado mine and opened copper-silver ore on the 2300 and 2500 levels.

In Jefferson County, the Legal Tender mine changed hands; the 500-ft. shaft was retimbered, unwatered to the 200 level, and drifting begun. The Amalgamated Silver Mines shipped silver ore; the controlling interest was sold, the purchasers taking steps to develop the Free Coinage mine. The Mount Washington mine, at Wickes, an old silver producer, was opened up and shipped some galena. The Angelica made daily shipments. The Economy, at East Helena, installed a new mill, and the Comet at Boulder did development work. Mining was active in Lewis and Clark County. Gold dredging yielded a smaller output. The Snowstorm, in Lincoln County, began a 2200-ft. tunnel. In Beaverhead County, the Pearl Smith shipped graphite ores for Government use. The Southern Cross mine, at Georgetown, made a good production of gold.

Properties that changed hands included the Butte Central, bid in by Anaconda; the Margaret claim at Butte, sold to New York interests; the Polaris mine, near Dillon, sold to the new Silver Fissure company; the Crystals Copper property, optioned to Crystals Goldsmith Co.; the Butte Copper Czar; and the Ophir mine and mill, taken over by the newly formed U. S. Manganese Corporation. The Barnes King leased and optioned the Mount Pleasant mine and also operated the Shannon and Piegan-Gloster mines.

Butte & Superior won its case against Minerals Separation, but lost to Elm Orlu in regard to extracting the latter's ore. The former case was later ordered reopened. Damage suits against North Butte for deaths in the fire of June 6, 1917, were thrown out of court.

NEVADA

Much activity was displayed in most districts in Nevada during 1918. Labor shortage caused a decrease in production of all major metals. Discovery of high-grade ore in the Tonopah Divide mine stimulated development in that section. Deep development in the Comstock mines was rewarded with a large gold production.

The Unevida company worked old Comstock tailings from the Carson River bed. The important copper producers maintained a steady output, Nevada Consolidated and Consolidated Coppermines, in White Pine County, leading in production, and the Bluestone and Nevada Douglas companies contributing a good output.

In Clark County, the Yellowpine district yielded a large tonnage of lead and zinc ore, leading in the production of the latter. The Yellowpine mine installed a new crushing and sorting plant. The Sultan dry concentrator, at Goodsprings, was enlarged, and the Boss mine shipped ore carrying platinum to the Palau Metals Co., in Los Angeles. Manganese mining was active around Las Vegas, and vanadium ore was shipped from the Mountain Top property.

In the Searchlight district, the Wesselhoft Copper began shipments of copper glance ore. The Big Casino mine rebuilt its mill, adding a flotation unit, and shipped a high-grade concentrate. Leaching tests were made on Quartette low-grade copper ores with success. The Techatticup mine discovered a rich new oreshoot. In Lincoln County, the Prince Consolidated shipped a large tonnage of fluxing iron-manganese ore. The Virginia Louise property resumed operation and improved its plant.

The Silver Dyke, at Sodaville, and the Edmunds Buchanan group at Winnemucca shipped tungsten ore to the mill at Toulon. Sulphur was mined by the Nevada Sulphur in Humboldt County; also in the Cuprite district of Esmeralda County. Rochester Combined completed its mill. A good oreshoot was opened on the Spearhead property. In the Jersey section of Lander County, the Farretta cinnabar company started a new reduction plant. Oil shale was discovered near Eureka. Antimony was shipped from the Austin district by the Nichols-Layng Chemical Company.

The Bluestone property at Yerington was sold to the Dominion Reduction Co., of Canada. The Nevada Hills mine, at Churchill, changed hands, as did the old Harrold property at Spruce Mountain. Claims near Rose Creek in Humboldt County were purchased by the Pacific Tungsten Co., and the Como Consolidated, in Lynn County, was taken over by Truett, Taylor & Bonneau, of New York. The Hoosier property at Goodsprings was acquired by Los Angeles interests, and the Manganese Association at Las Vegas was leased for three years. A receiver was appointed for Nevada Austin. Manhattan White Caps won its suit against Manhattan Morning Glory, the latter being restrained from sinking on former's ground.

New Mexico

The Chino Copper and Burro Mountain Copper companies operated steadily during 1918. The former company purchased about 40 claims of the Hermosa Copper Co. At Hanover, the Empire, Republic and other mines shipped zinc ore and the Hanover Bessemer, iron ore. A new shaft was started by the Republic company; also by the United States Copper Co. At Steeple Rock, the Carlisle plant shut down, the mill being restarted later. Erection of a cyanide mill was begun by the Mount Royal company. At Pinos Altos, development of the Calumet property was undertaken; the Cleveland mill ran steadily.

At Lordsburg, no great labor shortage was experienced. Manganese and fluorspar properties were opened in the vicinity. Truck lines for hauling ore were established to both Red Rock and Cap Rock. The Viola and Last Chance properties were taken over by Pittsburgh interests and a 50-ton mill put into operation. The Lawrence Mining Co.'s lease on the Bonney mine expired, and the owners began blocking out milling ores preparatory to erecting a mill; steady shipments were maintained. Exploration of Southern group showed good milling ore. Great Eagle mine, at Red Rock, attained a monthly production of 600 tons of high-grade fluorspar. Cap Rock mines made monthly shipments of psilomelane.

In Taos County, the R. & S. molybdenite property developed ore and rebuilt its flotation mill. The Grubnau zinc oxide plant, in Santa Fe County, operated continuously. At Mogollon, in Socorro County, the Socorro mill was burned, but quickly replaced.

South Dakota

Development work was practically at a standstill throughout 1918 in the Black Hills district of South Dakota, owing to acute labor shortage, especially of shovelers, despite increased wages. Golden Reward suspended early in the year. Homestake maintained full tonnage until October, when Mineral Point mill, having 100 stamps, shut down, followed by Golden Star mill, with 200 stamps, on Nov. 1. At the year's end, Homestake was operating at about 70% of normal tonnage and with a much smaller proportion of deep-level ore produced.

The Mogul, at Terry, built 1600 ft. of tramway from tunnel to mill bins. Mogul and Trojan both operated below normal capacity. Bismarck was worked on lease for gold and tungsten for several months. Custer Peak enlarged its main shaft and purchased the Jungle property. Tinton resumed after 10 years' idleness. The Titanic started a 1200-ft. tunnel, and the Cutting, at Deadwood, erected a shafthouse and prepared to sink a shaft.

In Pennington County, the Keystone shipped mica and lithia ores. The Bob Ingersoll changed hands and shipped columbite-tantalite ores, also recovering amblygonite, for which there was no market. The American Tin and Tungsten Co., at Hill City, remodeled its tin mill; a new hoist was installed at the Cowboy mine. In Custer County, the Rare Minerals Co., at Custer, installed a 50-ton concentrator to handle tin and tungsten ores. The Old Mike mica mine was sold to the Berne Mica Corporation.

Oregon

Labor shortage was marked in Oregon in 1918. Chrome mining was vigorously carried on, especially in Josephine and Jackson counties, many deposits being opened in the latter. Several hundred miles of wagon roads were built to market these ores. From September on, the market for chrome and manganese ores became demoralized, the latter having also been mined to considerable extent.

Gold mining fell off, particularly dredging, three dredges being in operation at the end of the year. In the Gold Hill region, only three properties were under development, namely, the Sylvanite, Whitney, and Nellie Wright. The Rainier Mercury Co. took over the Utah Mercury Co.'s claims and increased its number of retorts. In Baker and Grant counties, a large gold production was made.

In Baker and Josephine counties copper mining was active. The Alameda Copper Co. at Grant's Pass began the erection of a 200-ton concentrator and a 150-ton blast furnace. At Homestead, the Iron Dyke company began sinking, and the Azurite blocked out ore carrying zinc, lead, silver, and copper.

Washington

Shipbuilding drew heavily upon the mine-labor supply in Washington in 1918, conditions improving after the armistice. The Northport lead plant early resumed operation and ran steadily, though with a falling off in output in the latter part of the year. The Tacoma smeltery steadily sought siliceous ores and silica for fluxing purposes. Shipments of war minerals, except magnesite, were small. Transportation was improved by the introduction of motor trucks on highways built over the routes of former roads. Little roadbuilding was done within the year, owing to war restrictions.

Development of magnesite deposits in Stevens County was rapid, the Northwest Magnesite Co. and the American Mineral Production Co. being the only producers. The Neutral group, at Chesaw, Okanogan County, shipped iron ore to the calcining plant of the Northwest company. The Republic district shipped gold ore steadily, the Lone Pine-Surprise, Last Chance, and Knob Hill being among the more active properties. The Boundary Red Mountain Co. was inactive. Properties shipping copper ore included the United Copper, Copper World Extension, Lone Star and Washington, Loon Lake, and Reardon. The Sunset was reopened on a moderate scale; a 150-ton mill was completed in August and operated; railroad connection was made with mine and mill. The Belcher mine changed hands. The Tago mine began production. The United Copper ceased shipments to Trail and signed a contract with the Tacoma smeltery.

In the Metaline district, the Lead Zinc mine shut down. A three-year option was taken by the Diamond R company on the Diamond R and Bella May properties of the Spokane Lead Co. The Electric Point mine near Northport began erecting a tramway. Tin was discovered on Moran prairie south of Spokane.

Texas

Quicksilver mining and the sulphur production of the Freeport Sulphur Co. were the notable operations in

Texas in 1918. Quicksilver producers included the Chisos, Warfa, Mariposa, and Big Bend mines, at Terlingua, and the W. K. Ellis mine, near McKinney Springs. Exploration and development of sulphur deposits in Culberson and Reeves counties continued. The Presidio silver mine operated continuously, according to the U. S. Geological Survey, and desultory mining was carried on in the Van Horn and Sierra Blanca districts. The state's output of silver was 590,000 oz. Small shipments of copper were made from the "Red Beds" of Foard and Knox counties. The Texas Copper and Refining Co. was incorporated to exploit these beds. In Burnet County, the Southwestern Graphite Co. started an electrostatic-process mill and purchased flotation equipment to treat graphite dust.

Arkansas

The Batesville manganese field of Arkansas was active in 1918, investments for the year exceeding the total up to the beginning of the year. A steady production was maintained. Shortage of labor restricted the output and affected the installation of washing plants. Until 1918, most of the ore produced was nugget ore, mined with pick and shovels. During 1918, the big deposits of wash, or fine ore, were the main attractions for the larger operators, who spent most of the year in proving such bodies and designing plants to prepare the ore for market. The finer contents were lost with log washers and screens, so Joplin-type jigs were installed. Jigs and washers were found the most efficient combination. Only a small tonnage of concentrates was shipped. Labor shortage was overcome to some extent by using steam shovels.

In the zinc field of northern Arkansas, the largest production came from the Zinc camp in Boone County. With the shipping point close by, and mining done mostly in ground requiring little powder, operations were profitable. Practically all the output was sold on the open market.

Kentucky and Other States

Wages advanced in the fluorspar district of Kentucky over 100% in 1918, but failed to draw sufficient labor. Car shortage and railway embargoes in the first quarter interfered with shipments. Motor trucks largely supplanted wagons for haulage to shipping points. Fluorspar was classed as a war mineral too late to stimulate its production. Many properties changed hands during 1918 in both the Kentucky and Illinois portions of the fluorspar district, but no substantial new producers were brought in. The chief development brought about by the entrance of new capital was the reopening of old mines. The one transaction of importance during 1918 was the sale of the Kentucky Fluorspar Co., with other mines differently owned, namely, the Susie Beeler and Mary Belle, to one holding company, for $500,000, which company has not assumed a corporate title. Several new concentrators were built, and there was a marked advance in installing more substantial machinery and mine equipment. One important development was the change, on a large scale, from steam to crude-oil-burning plants and electrical installations for pumping.

In Tennessee, operation in the Ducktown basin was steady throughout 1918. Many small manganese properties were under development in Johnson and Carter counties. In Virginia, manganese mining was pursued in various localities. The Crimora company put both mills in operation. In Georgia, the Chestatee Pyrites and Chemical Co. started an experimental mill, built 10 miles of railroad, and enlarged its hydroelectric plant. In North Carolina, the Moody Mica Co., at Franklin, was sold to Philadelphia interests after producing $40,000 worth of mica. In Maine, the old Douglass property, at Blue Hill, was developed by the American Smelting and Refining Co.; 100-150 tons of chalcopyrite was mined and milled daily and the concentrates were shipped to Perth Amboy.

Alaska

According to the advance statement of the U. S. Geological Survey, the value of Alaska's mineral output in 1918 decreased $12,000,000 from that of 1917 and was the smallest since 1914. The decrease was chiefly in copper and gold, and was due to shortage of labor and ships and to high costs.

Fourteen copper mines were operated, against 17 in 1917. Six mines in the Ketchikan district yielded 1,781,000 lb.; four in the Prince William Sound district, 15,060,000 lb.; and four in the Chitina district 52,585,000 pounds.

About 28 gold dredges were operated in 1918—20 in Seward Peninsula, three in the Iditarod district, two in the Fairbanks district, and one each in the Circle, Yentna, and Kuskokwim districts. About 25 gold-lode mines were worked, compared with 31 in 1917.

About 94½ tons of cassiterite, containing 113,000 lb. of tin, was mined during the year. Most of this came from the York district, Seward Peninsula, where one dredge was operated. Stream tin was also obtained by sluicing at one mine in the district and at several mines in the Hot Springs district.

Palladium was produced for the first time, coming from the copper ore of the Salt Chuck mine, near Ketchikan. Platinum also was derived from this ore, as well as from the gold placers of the Dime Creek district, on Seward Peninsula. The new Salt Chuck concentrator is said to have operated successfully.

In the Juneau district, the Alaska Gastineau, Alaska Juneau, and Ready Bullion mines were operated steadily, though at reduced capacity. In the Sitka district, the Chichagoff mine ran throughout the year, and development work was done at the Hearst Chichagoff.

In the Copper River region, the Kennecott Bonanza and Jumbo mines were operated steadily, except for a two-weeks' shut-down at the Bonanza. Jumbo shipments were curtailed for six weeks. The ammonia-leaching plant at the end of 1918 was able to treat all the concentrator tailings.

The Mother Lode shipped ore during the winter, and continued shaft sinking. The Nugget Creek mine of the Alaska Copper Corporation was operated part of the year, and shipped ore and concentrates. The North Midas Copper Co.'s gold mine was operated part of the year.

In the Cook Inlet-Susitna region, the chromite mine at Port Chatham was operated throughout the season, producing somewhat more than in 1917. A wharf and tramway were built, and a stamp mill was installed. Chrome discoveries were reported on Peters Creek.

Mining in Ontario in 1918

BY THOMAS W. GIBSON*

WHEN all the figures are compiled, it will probably be found that the value of the mineral production of the Province of Ontario during 1918 will considerably exceed that of any previous year. The staple metals of Ontario are nickel, copper, silver, and gold. The first two were produced in greater quantity than ever before. Gold will show a slight increase over 1917, but a reduction as compared with 1916, whereas silver will show a falling off of about two million ounces. The prices of nickel and silver have both advanced; the price of copper has receded, and gold, of course, remains stationary. The net result is a decided increase in the aggregate value of these metals.

GOLD PRODUCTION INCREASED

The production of gold in 1917 was valued at $8,698,735; in 1918 it was about $9,200,000. This increase of about 5 or 6%, although not great and made in face of the severe and accelerating handicap under which gold mining has been laboring for the last four years, shows the essentially sound position of gold mining in the province. The main gold field is that of Porcupine, where only two mines, the Hollinger and McIntyre, remained in operation throughout the entire year. The mill at the Dome mine, normally a large producer, was idle for all of 1918, and Porcupine Crown, Schumacher, and Vipond-North Thompson were likewise unproductive for most of the year.

At the Kirkland Lake camp six mills are now in existence. At the Lake Shore mine, milling operations began in March, and, up to the end of September, 11,253 tons of ore had been treated and a recovery of $271,265, or $24.10 per ton, had been obtained. The Kirkland Lake's new mill started work in December. The Patricia, at Boston Creek, and the Davidson, at Porcupine, were also new producers in 1918. At Boston Creek a new find of gold telluride on the Miller Independence attracted considerable attention.

HOLLINGER OPERATES AT HALF CAPACITY AND MCINTYRE AT FULL CAPACITY

The Hollinger mine, at Porcupine, is preëminently the leader in gold production in this province, and is, in fact, one of the great gold mines of the world. In 1918 it yielded in bullion about $6,200,000. Up to the end of 1918 its total output was about $26,000,000, and it has paid over $9,000,000 in dividends. The mill operated 100 stamps during the year, or half capacity. Scarcity and inefficiency of labor, combined with high wages and increased cost of supplies, were formidable obstacles, yet the mine was kept in operation and made good profits. The new central six-compartment shaft was placed in service down to the 800-ft. level, and sinking was continued to the 1250-ft. level. P. A. Robbins, director and general manager of the mine from the beginning, resigned to join the United States overseas forces, and was succeeded by A. F. Brigham.

The McIntyre mine continued its active development and operated the mill at capacity. The property now includes what was formerly the McIntyre property, the Pearl Lake, the Jupiter, and Plenaurum, and an option has been taken on the Newray. Production in 1918 was about $1,600,000. Ore reserves of June 30, 1918, were $4,490,432. At the Dome mine, although the mill was closed, underground development was continued. The Dome Lake and West Dome operated for a few months only. In the northern part of Whitney Township, the Davidson property was worked with fair regularity throughout the year, and apparently with favorable results. At the more recent gold-mining camps, Fort Matachewan and Lightning River, development work has been continued, but they have not yet reached the producing stage. The Otisse claims, in the former field, give much promise.

VALUE OF SILVER PRODUCTION SECOND TO BANNER YIELD IN 1912

Silver production for 1918 was 17,500,000 oz., with a value of about $16,675,000, as against 19,479,692 oz. in 1917. In value the production of 1918 was second only in the history of Cobalt to that of 1912, when the output at 60.8c. per oz. was worth $17,408,935. The Cobalt area is still producing freely, though on a declining scale. The total yield, including the output of Casey Township, South Lorrain, and Gowganda, from the beginning to the end of 1918, has been about 292,000,000 oz. Nipissing, Mining Corporation of Canada, Kerr Lake, O'Brien, Coniagas, McKinley-Daragh-Savage, Buffalo, and Temiskaming were the leading producers. Considerable work was done during the year in the southeastern part of the camp in the hope of encountering rich veins, such as those found in the Keewatin series at the Temiskaming and Beaver mines. The lower contact of the diabase sill, reached at 1675 ft. in the latter mine, has not proved very productive. On the north, in Bucke Township, the old Green-Meehan property has been reopened and has yielded some good ore. The Mining Corporation is sinking a shaft at North Cobalt.

The Miller Lake-O'Brien, the best mine yet found in the Gowganda area, is proving a rich deposit, and its exploition has stimulated interest in nearby claims. In South Lorrain, the Wettlaufer and Keeley properties were operated.

There were no labor troubles in Cobalt during 1918, a sliding scale being in operation by which wages increased 25c. per day with every 10c. increase in the price of silver.

REORGANIZATION OF INTERNATIONAL NICKEL COMPANY

The nickel contents of the Sudbury mattes amounted to 44,700 tons in 1918, compared with 41,887 tons produced in 1917, and the value of the nickel in the matte was $26,800,000, as against $20,943,500 in 1917. An important reorganization took place, by which the International Nickel Co. of Canada absorbed the old Canadian Copper Co., the power companies, and the refinery at Port Colborne. The head office of the new company is in Toronto, through which all export business will be handled. The International Nickel Co. of Canada

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will sell nickel, blister copper, and matte. A. D. Miles is president, and J. L. Agnew is vice-president and general manager. The chief supply of this company's ore came from the Creighton mine, although a small production was taken from the Cream Hill mine. The extensive program that has been under way at the Creighton mine for the last four years, by which the method of mining was changed and a new surface equipment installed, has been completed, and the mine is now yielding approximately 125,000 tons per month. To avoid shortage of water-power during the dry season, the International Nickel Co. is putting in a large dam on the Spanish River above High Falls, and this development is not expected to be completed until 1921.

Operations of Mond Nickel Co. and British America Nickel Corporation

The Mond Nickel Co. operated the Garson, Worthington, Levack, and Bruce mines. The last named yields a siliceous ore which is valuable for flux, and also carries some copper. Developments at the Levack mine have been satisfactory; it has now been shown that this deposit is one of the large orebodies of the Sudbury district, and that the ore is of a grade above the average. The Mond company did considerable diamond drilling on property adjoining the Creighton mine, in the hope of striking an extension of this rich orebody. Four drill holes from 2500 to 3000 ft. deep were put down, but the results have not been announced. The output of the Alexo nickel mine, Porcupine district, amounting to about 10,000 tons, was shipped to Coniston and smelted with the Mond company's ore.

The British America Nickel Corporation was engaged chiefly in construction work in 1918. Many of the buildings at the smeltery are now completed, and it is expected that smelting will be begun before the end of 1919. Development at the Murray mine was continued, and a shaft house, ore house and storage bins were erected. Electric power in the neighborhood being practically all in use, the company decided to build its refinery near Hull, Quebec, where power from the Ottawa River was available. Active construction on the refinery plant has been going on for the last eight months. About 115 tons of metallic nickel, besides a quantity of nickel oxide, was produced by the refineries treating the silver ores from the Cobalt mines.

Copper Mining Unprofitable in Ontario

High operating costs, increased freight and smeltery charges, and the lack of a customs smelter made copper mining in Ontario in 1918 unprofitable. The only non-nickeliferous ore shipment was a trial lot from the Hudson Copper Co. at Havilah. The Sudbury mattes contained about 23,000 tons of copper, valued at $8,500,000, as compared with 21,197 tons, worth $7,842,290, in 1917, the copper being valued in the matte at 20c. per lb. Blister copper is one of the products of the International company's new refinery at Port Colborne, which has a capacity of refining 10,000 tons of nickel and a corresponding quantity of copper per annum.

During the first nine months of 1918 154,243 tons of iron ore was shipped, of which 69,357 tons was exported. The principal production was by the Algoma Steel Corporation from the Magpie mine, and by Moose Mountain, Ltd., from the mine of that name. The Magpie ore is siderite, which is roasted and nodulized. Moose Mountain ore is subjected to magnetic concentration, and is then briquetted. In both cases the product is first-class for bessemer use. Small shipments were made by the Poe Mining Co. from Palmerston Township, and by the Canadian Union Iron Mines Corporation from Drummond Township. There was charged into the blast furnaces of the province upward of 1,500,000 tons of iron ore, mostly imported, producing about 890,000 tons of pig iron. In 1917 the quantity of ore smelted was 1,316,199 tons, and the quantity of pig iron produced, 691,233 tons. For the nine months ending Sept. 30, 1918, steel production amounted to 668,333 tons, most of which was shell steel.

Cobalt, Nickel, Lead, and Non-Metallic Products

The silver refineries recover the cobalt, nickel, and arsenic contents of the Cobalt ores, as well as the silver. Hitherto, the two former have been largely produced as cobalt oxide and nickel oxide, but there is now a strong tendency to convert these substances into the metallic form. During the first nine months of 1918, 217,291 lb. of metallic cobalt and 582,992 lb. of metallic nickel were produced, in addition to 397,728 lb. of cobalt oxide and 5592 lb. of nickel oxide. Other cobalt and nickel compounds, amounting to 367,923 lb., were also made. The value of these subsidiary contents of the silver veins for 1918 is probably not less than $2,000,000. Much of the metallic cobalt is utilized in making stellite, a cobalt-chromium alloy of value for high-speed tools.

For the nine months ended Sept. 30, the lead mine and smeltery at Galetta, on the Ottawa River, produced 1,291,571 lb. of lead, valued at $115,117. This mine is owned by the James Robertson Estate, Montreal, and the entire product is shipped to the company's works in that city.

Three feldspar quarries were in operation in Ontario in 1918, producing until November, when the demand slackened, an average of 2500 tons per month. The productive feldspar area is near Verona, on the Kingston & Pembroke Ry.; the principal operators being Feldspar, Ltd., Eureka, and Feldspar Quarries, Ltd. The product goes, in peace times, to the potteries of East Liverpool, Ohio, and Newark, N. J., but a large proportion of the 1918 output was used by the United States for war purposes.

Mica was produced by the Lacey mine, near Sydenham, the output being about 6000 lb. per week of rough-cobbed mica. The mine, which is operated and owned by the General Electric Co., was worked on the seventh level, about 185 ft. below the surface. All the other mica properties were inactive, owing to the war.

Three companies operated graphite mines: Black Donald, at Calabogie; Globe Graphite, at Fort Elmsley, and Timmins, in North Burgess Township. The first two mines are worked by old-established concerns, the former employing about eighty men and the latter about fourteen. The vein on the Timmins property has been stripped for a short distance and traced for about a mile and varies in width from 25 to 75 ft. A 200-ton mill is being erected, and is expected to be in operation by Feb. 1, 1919.

The demand for pyrites was urgent in 1918, the principal producer being the Nichols Chemical Co., whose

mines are at Northpines, Goudreau, and Sulphide. This company has also an acid plant at the last-named place.

The yield of petroleum in Ontario in 1918 was greater than in 1917, owing to the development of the new field in Mosa Township. From appearances, however, Mosa is not likely to have a long life. The natural-gas areas are situated on the east and north shores of Lake Erie, and supply a large part of the population there with fuel. Severe weather conditions in the winter of 1917-18, concurring with a shortage of gas, led the Legislature to confine the use of gas to domestic consumers, thus cutting off the supply from industries and from all classes of manufactures.

Salt from the Lake Huron area, quartz from Dill and other places, talc and fluorspar from Madoc were also produced in increased quantities. The last-named was in active demand up to $30 per ton for use in steel plants. A small quantity of gypsum is mined annually in the valley of the Grand River. Building materials, such as cement, brick, stone, and lime, continued in fair production, notwithstanding the lessened activity in the building trades.

Mining in British Columbia in 1918

By ROBERT DUNN*

THE outbreak of war in 1914 served to stimulate British Columbia's mining industry, which settled down to a steady advance during the following year, and in 1916 reached its peak, the value of the output for the latter period creating the new record of $42,290,462. There was a decline of $5,280,070 in 1917, and the completion of 1918 brings much speculation in the Canadian West as to what the official returns for the year will show and what the future holds in store.

The copper output for 1918 was probably greater than that of 1917, and the same may be said of coal.

The Department of State has definitely declined to consider the restriction on Brazilian manganese and chrome, which was suggested by the War Industries Board.

Silver production was about the same, but the final figures will probably show that there was a decline in the output of gold, lead, and zinc. High costs and the difficulty of obtaining labor were mainly responsible for the unsatisfactory indications in respect of the three last-mentioned products. In fact, these handicaps affected adversely all mining enterprise in the province throughout 1918.

The market quotation for copper, fixed by the government, remained firm throughout 1918 at a good figure, and the big companies naturally adopted and maintained a policy of keeping their output as nearly as possible at the maximum. Under the circumstances it was to the advantage of concerns having extensive facilities to meet the increasing schedule of wages and thus avoid the danger of labor troubles. The slogan was "Get out the ore!"; and the larger companies, particularly the Granby Consolidated Mining, Smelting and Power Co., Ltd., adhered to it with good results.

British Columbia's copper output during 1916 was 65,378,364 lb. and in 1917 it was 59,007,565 lb. So far as the figures available permit analysis, the output for the first nine months of 1918 is as follows: Granby Consolidated Mining, Smelting and Power Co., Ltd., 29,081,635 lb.; American Smelting and Refining Co.,[1] (British Columbia ores treated at the company's Tacoma, Wash., smeltery), 16,344,376 lb.; Ladysmith Smelting Corporation, (now closed), 92,212 lb., making a total of 45,518,223 lb. The last quarter of 1918, therefore, must attain a production of 13,489,342 lb. to equal the output in 1917. Inasmuch as the Granby and Tacoma smelteries have been producing at the rate of 13,779,972 lb. per quarter, and no mention is made of the production of the Trail smeltery of the Consolidated Mining and Smelting Co., Ltd., of Canada, it is to be presumed that the final figures for 1918 will be somewhat better than those for 1917.

The coal output of British Columbia up to the end of October, 1918, was 2,204,255 gross tons, so that to equal the 1917 production of 2,398,715 tons it is patent that the output of November and December must total 194,460 tons. Considering that the production for October totaled 217,482 tons, it is probable that the production for 1918 will exceed that of 1917 by at least a quarter of a million tons. The coal operators faced some hard problems during the year, especially on Vancouver Island and in the Crowsnest field, which are the greatest producing districts. On Vancouver Island, in addition to costs and labor, there was the difficulty, at least in one instance, of replacing the worked-out ground with a new mine and maintaining production. There was also a serious accident in Nanaimo, 16 men losing their lives through the breaking of a cable on a descending cage, and the ravages of Spanish influenza curtailed the tonnage to a large extent. In the Crowsnest field, the strike at Fernie and Michel camps to obtain a single shift at some of the mines, which were said by the miners to be dangerous under the two-shift system, caused a drop in production of at least 60,000 tons.

Gold production was affected more than that of any of the other metals because of its fixed price. The Rossland camp, operated by the Consolidated Mining and Smelting Co. of Canada, and the greatest single producer of gold in the province, was closed early in the year. Similarly, the placer camps were hard hit, and the gold output for 1918 will undoubtedly reflect the conditions described.

Lead and zinc production was also hampered by high costs and lack of labor. Many of the small operators of the Kootenay and Boundary districts found it impossible to continue shipments at a profit. A comparative statement, recently issued by the Consolidated Mining and Smelting Co. of Canada, shows the tonnages received at the Trail smeltery for treatment during the first

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[1]The Tacoma smeltery produced 273,626 lb. of copper from ores of the Yukon Territory during the same period.

nine months of the last three years. These were 415,983 tons in 1916; 327,639 in 1917, and 217,417 tons in 1918. At the end of October, 1917, 148 mines were shipping to the Trail smeltery more or less regularly, but on Oct. 31, 1918, the total number of mines shipping was only 122.

It is interesting to note that the Trail smeltery has been a storm center throughout the year, it being charged by small-mine operators that its custom rates are excessive. The reply from the management was to the effect that the increases that have been announced are fully justified by conditions. As a result of the former's agitation, the Dominion government authorized an investigation of the affairs of the Consolidated Mining and Smelting Co., with particular reference to the conduct of the Trail smeltery.

Under war pressure, some minerals were brought to light in British Columbia of which formerly little had been known in the Canadian West. Most important of these is manganese, of which several promising deposits have been located in the Cowichan district, Vancouver Island. Chromite also has been discovered, and several of the deposits are encouraging. A large molybdenite property at Alice Arm, scheelite deposits in the Cariboo district near Barkerville, and platinum in the Tulameen River district are among the more notable developments.

The phrase "the mineral resources of the country have been but scratched" can be applied to British Columbia literally and without exaggeration. Naturally the annual output fluctuates considerably, but an upward curve has been steadily maintained. This tendency has been more marked during the last few years, and with the return to normal conditions, and in view of the demands to the reconstruction period, the importance of the mining industry of the province is bound to be demonstrated to an increasing extent.

Mining in Manitoba in 1918

BY R. C. WALLACE*

In northern Manitoba, 6300 tons of copper ore was shipped from the Mandy mine to Trail, B. C., in 1918. A minimum of 10,000 tons will be hauled by wagon during the winter, to be ready for water transportation in the spring. At the Flin Flon property, diamond drilling was continued until June, when the preliminary mapping of the orebody was completed. It is expected that work will proceed on this property, now that the difficulties of development incident to war conditions have been removed. Necessary development work includes the building of a railway approximately 80 miles long from The Pas, the erection of a smeltery on the property, and the development of power and power transmission over a distance of at least 35 miles, and probably 60 miles. Several discoveries of copper sulphides were made in 1918 in the Athapapuskow-Copper Lake areas.

The Rex mine, on Wekusko Lake, is responsible for the first continuous production of gold in Manitoba. On this property a 40-ton Lane mill started operations in May. The ore is stoped from a 100-ft. level. The vein, the width of which continues to average 4½ ft., shows uniformly high assays. Development is proceeding on other properties on Wekusko Lake, and gold discoveries as well have been made on Copper Lake and on Knee Lake, on the historic fur-trade route from Norway House to York Factory.

In the Rice Lake district, sinking has continued on the Gold Pan property to the 200-ft. level, and a small stamp mill will be installed during the winter. North of the Hole River, the Luleo property, a wide shear zone mineralized with gold has been surface prospected, and plans are now formulated for extensive development. Machinery will be installed this winter to operate the property on a large scale.

In the Falcon-Star Lake district, considerable interest has been taken in the development of scheelite and molybdenite properties. The molybdenite occurs in pegmatite veins, parallel to the granite contact, and the scheelite in stringers in epidotized zones of greenstone also parallel to the contact. Several tons of tungsten ore have been shipped to the Mines Branch at Ottawa for treatment, that the values and milling methods might be determined.

During 1918 a Manitoba branch of the Canadian Mining Institute was established. This branch will undoubtedly be of assistance in promoting the best interests of the industry in the province.

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Mining in Cuba in 1918

The center of mining activities in Cuba in 1918 continued to be the Province of Oriente, which during the first six months of the year produced nearly 13,000 tons of copper concentrates, 407 tons of chrome ore, 471,317 tons of iron ore, and 40,781 tons of manganese ore. These are official figures. Those for the second semester are not yet available, but there is no apparent reason why they should not be about the same.

Owing to shortage of labor and shipping tonnage, the production of copper and iron decreased 16% and 30%, respectively, as compared with the second half of 1917. The pressing demand for manganese, however, creating special sea transportation facilities for this mineral, made it possible to surpass by 47% the output of the previous semester. There is no doubt that, with the aid of good roads, this amount might have been exceeded, in view of the abundance of manganese deposits; but the Province of Oriente is still almost destitute of highways. As high as $22 per ton for freight has been paid from mine to railway—a particularly excessive amount in a country of such a size and shape as Cuba. No gold was produced in the first semester of 1918, as compared with an extraction of 2650 tons of ore in the second half of 1917.

A large amount of exploration was done during 1918 throughout the province, and results indicate a probable increase of considerable importance in Oriente's copper production in the near future; and the same may be said of the remaining five provinces of Cuba.

New companies organized during 1918 are absorbing the comparatively large number of concerns created in recent years. Many failures have been registered, as was to be expected; but the work thus far accomplished has provided a wholesome stimulant, and, as a result, Cuba may be classed as a copper country. Actually, however, but one mine outside of Oriente has produced

copper in commercial quantities during the year, namely, the Matahambre mine, in the Province of Pinar del Rio. Its output for the year is approximately 75,000 tons of ore. The erection of a 1000-hp. power plant at the coast is reported, and a mill at the mine, 10 miles inland, has been completed. Silver and coal deposits were prospected during the year in various parts of the island.

Another phase of mining which has displayed great activity, but which at present is at a low ebb, is oil mining. Havana Province has been the main field of activity. Three wells have been sunk to 2000 ft. and over, but by far the majority have been let down to about 1000 ft. Three companies, of a total of about 40, have met success in obtaining productive wells, one having sunk 13. The output for the year will be about 32,000 barrels, of which 24,000 is credited to the company alluded to. This does not include oil used as fuel on the oil properties by themselves, of which no figures are available. The price obtained during the latter months of 1918 was 12½c. a gallon at the nearest railway station.

Surface indications of oil are to be found over a large stretch of territory, and the total of about 60,000 barrels which has been obtained to date represents the output from wells in an area of about five acres. It should be added that, if efforts so far have achieved less success than was expected, this has been due chiefly to the unsound basis on which the matter has been handled.

Mexican Mining in 1918

THE payment of dividends during 1918 by a number of concerns operating in Mexico, such as the Amparo Mining Co., the Greene Cananea Copper Co., the Lucky Tiger Combination Gold Mining Co., the Mexico Mines of El Oro, Ltd., the Esperanza Mining Co., the Santa Gertrudis Co., Ltd., the El Oro Mining and Ry. Co., and the two important American smelting companies, is an indication that conditions in some parts of the country have been better than in others. A number of other properties started operations during the period, in some instances following the blowing in of American-owned smelteries in the neighborhood.

The resumption of work, however, has arisen largely from necessity, coupled with a confidence in the future which was born of a hope that a return to activity on the part of the operators would engender a certain consideration on the part of the Mexican authorities. It was also hoped that Mexicans would recognize the fact that the evils existing are serious deterrents to national progress and development; and that the very existence of their own people is at stake.

The fact is patent to all careful observers, however, that Mexico is rotten at the core, and that no amount of initiative on the part of the citizens of foreign countries will have an appreciably favorable effect on the general conditions. The line of demarcation between the various groups of bandits in many districts and the federal authorities has grown indistinguishable, and the aims and objects of all factions in the country seem to be much alike. Law and order and respect for human life are at a discount, the German element being, apparently, the only section which receives special consideration from the authorities. Drastic action may be expected to be taken in the near future to remedy a state of affairs that has become intolerable. As soon as the European tangle has been unraveled, the powers that are interested in the maintenance of law and order in Mexico will be able to give the matter the attention it deserves.

The Northern States

Mining in the State of Tamaulipas has been at a standstill. The mountainous sections of the state are still occupied by revolutionists, and each pack train of burros has to be convoyed by Carrancista soldiers. In addition to this, it is not possible to secure explosives with which to continue mining. Neither camps nor commissaries can be established, because the revolutionists, as well as the Carrancista soldiers, rob them. The federal troops, in fact, when away from general headquarters, are as dangerous as the revolutionists. Of the number of properties formerly in operation in this state, no more than 20 are now paying the federal taxes which are required to insure a continued official recognition of ownership. Labor around the towns is abundant at from 75c. to 1 peso per day, with lack of employment for the poorer classes. As a consequence, stealing, suffering, and sickness are rampant, and a high mortality rate is apparent.

A gradual resumption of mining is in evidence in the states of Coahuila, Chihuahua, and Sonora, and several smelting plants are in active operation. The Mazapil Copper Co., Ltd., which has extensive interests in Coahuila, including a small railway, smelteries, and various mines, conducted successful operations, and it is expected that the favorable results will continue. The reopening of coal mines, which have been practically inactive for more than four years, was announced, and a good output for 1919 is expected. A railway is being built between Sierra Mojada and Cienegas, which, when completed, will bring a large tonnage of low-grade silver-lead ores to the smelteries of Monterey. The repair of railroads, which were allowed to get into bad condition during the earlier years of the revolution, is now being gradually achieved. The Mexican Northwestern Ry. has lost several bridges at various periods of disturbance, and is now operating to Pearson, Chih., from Ciudad Juarez.

A number of mining properties in the western part of the State of Chihuahua will resume operations as soon as practicable. Regular shipments are being made from the Cusi property to the Chihuahua smelteries. Plans are under way to extend the Tigre transmission line, belonging to the Copper Queen works at Douglas, Ariz., to supply power for the mill of the North Tigre mine, in Sonora, Mexico. The Carnegie Lead and Zinc Co. continued operations at its property near Cananea, Sonora. The Cia. de Minerales y Metales has obtained a lease on the Santa Eulalia property, in Chihuahua, and successful expansion is expected. The Compagnie

du Boleo, operating in Baja California, continues to produce from its 1000-ton plant, and progress has been free from the interruptions common to the mainland.

The Central States

In the Guanajuato district all the more important mining companies operated throughout 1918. These include the Guanajuato Reduction and Mines Co., the Guanajuato Consolidated Mining and Milling Co., the Guanajuato Development Co. (the Peregrina and San Matias units), and the Cubo Mining and Milling Co. The Guanajuato Reduction Co. operated mostly on fill ore, the Guanajuato Development Co. on fill and freshly broken material. Both used cyaniding exclusively; but a large amount of flotation experimentation was carried on. The Guanajuato Mining and Milling Co. started the construction of a new mill in the La Luz district.

The Cubo company treated only freshly broken ore from its Villalpando mine at the mill of the Providencia Mining and Milling Co., which it has under lease and with an option to purchase.

In the El Oro district, the El Oro Mining and Ry. Co., Ltd., made progress in increasing output in an effort to lessen costs per ton. Ore reserves have been reduced to exclude any material having a combined gold and silver content valued at less than $7 per ton. Governmental and unofficial interference hampered progress at this property, as in other districts.

At the property of the Cia. de Santa Gertrudis mining operations were carried out during 1918, and the ore was sold. Developments in the mine have not added materially to the reserves. Milling operations at the Cia. Beneficiadora de Pachuca were under capacity, on account of the difficulties in the operation of the settling and filtration plant. It is expected that the installation of additional equipment will remedy the trouble. Flotation experiments were concluded, with results which showed that the process, in its present stage of development, cannot compete commercially with cyanidation for the treatment of the company's ore. Aluminum is now being used in place of zinc dust for precipitation purposes. A considerable saving is already assured, which will be increased as operations are extended.

The Amparo Mining Co., operating at Etzatlan, Jalisco, has been a constant producer and a steady dividend payer. It is reported that flotation tests have been satisfactory and that the necessary modification in the arrangement of the plant may be expected in the near future.

The Southern States

Little progress has been made in the opening up of properties and the development of the mineral industry in the southern states. The majority of the mines remained idle throughout 1918. In many cases road and railway construction must be carried out before further development can be expected.

Central and South America

FROM the mineral-exports standpoint the recent period of prosperity has been unevenly appreciated in Central and South America. Generally speaking, all operations have been hampered by a shortage of supplies, especially of oil and other fuel. Another drawback was the diversion of shipping from the usual routes, which was especially felt in connection with the exportation of low-valued material and inferior-grade products. A third detriment to progress was the stationary price for gold, which, on account of the steady rise in the price of all supplies needed to produce it, was somewhat neglected.

Bolivia did well, and prospered exceedingly. The principal product—tin—is exported in the form of a high-grade concentrate of considerable value per ton. The metal was urgently needed; and, for the most part, the necessary shipping space was forthcoming. Chile's principal product—nitrate—was in urgent demand, also for war purposes. The Allies had no synthetic plants, and were dependent on Chile. Prices rose, and output was stimulated. Exports to the United States were so largely increased that a lack of shipping for the purpose developed, and agriculturists had to go without. Chilean copper was exported in quantity, the two large producers straining every effort to take maximum advantage of the high prices prevailing. Peru's copper and gold output was stimulated for the same reason. Brazil suffered from shortage of ships for the transportation of manganese ore, and from lack of fuel; and the development of domestic deposits in the United States temporarily tended to relegate Brazil to a position of less importance in this respect.

Chile

Chile's great copper mine at Chuquicamata maintained a high level of activity throughout 1918. Following a slight reduction, caused in some measure by lack of shipping facilities, the end of the year showed increased output, the amount produced in October amounting to 9,854,000 lb. Operations have been somewhat hampered by the difficulties in obtaining sufficient fuel oil and other supplies, but it is anticipated that the copper output for 1918 will total about 100,000,000 lb. The plant has been working at a capacity in excess of that for which it was designed, and has been handling between 11,000 and 12,000 tons per day. Construction work, to provide for an ambitious scheme of extension, was continued throughout 1918 in spite of difficulties; and it is expected that, by June 1, 1919, the property will be producing at the rate of 160,000,000 lb. copper per annum. To obtain such an output the milling capacity will be raised to 15,000 tons of ore per 24 hours. Further additions will be made subsequently and as conditions warrant. The Chile Copper Co., as is the case with other foreign producing companies operating in Chile, is benefiting by the present rate of exchange, which is now about 10½d. per peso. Work at Chuquicamata has been helped by the circumstance that the local labor has proved itself to be efficient and unusually adaptable, with

the result that skilled work is now being mostly performed by Chileans.

Operations at the Braden Copper Company's Property at Rancagua

At the Braden Copper Co.'s property the continued driving of levels and crosscuts in the upper part of the Teniente side of the mine has developed large tonnages of ore of a highly satisfactory grade. The new electric railway from the mine to the coarse ore bins was completed early in 1918 and started operating on Apr. 27. This railway has a total length of 5750 ft., of which 5000 ft. is entirely underground and nearly all is of a uniform grade of 0.5%. The area of cross section of the tunnel is about 12 x 11 ft. Over its rails a 25-ton locomotive can handle up to 14 cars containing about 22 tons of ore each. By way of comparison it is interesting to note that the old railway is 6000 ft. long, 4½% grade, and covered with snow sheds for its entire length. Moreover, transport is subject to delay on account of snow slides. Over the heavy grade of 4½% a 25-ton locomotive could handle only three cars.

During September the first one of the two units of the new underground compressor station was put in operation. The station itself is about 3500 ft. from the portal of the tunnel and is roughly 290 ft. long, 34 ft. wide, and 28 ft. high. The sides are lined with concrete, and the roof is a reinforced-concrete arch. Compressed air is furnished by two reciprocating units capable of delivering 5000 cu.ft. per min. of free air each, compressed to 100 lb. per sq.in. To operate each of these units a 2300-volt 927-hp. motor is required.

During 1918 shaft "A" was sunk 690 ft. This shaft, when completed, will be 1650 ft. deep. It is 24 x 12 ft. in cross section, and when finished will consist of three compartments, a manway 6 x 9 ft., and two cageways 7 x 9 ft. each.

Plans for the new ore-pass gathering system, Teniente side, have been completed, and the work is well under way. In 1919 this system will be in operation, whereby all tramming will be reduced to a minimum and hand tramming nearly eliminated.

Since Jan. 1, 1918, six more Marcy mills have been put into operation, making the total installation of 18 ready for operating, of which 15 are being operated (these are all in a row); and a 60-ton crane has been erected in this aisle to facilitate repairs. Furthermore, 30 Hardinge mills have been equipped with new drives and 150-hp. motors. In addition, eight new gear-driven Minerals Separation flotation units of 20 cells each have been installed to replace similar belt-driven machines.

There are 35 Callow air cells. These will eventually be placed two in series, and there will then be 84 roughers and 12 cleaners. The air for these cells is supplied by two Ratteau-Battu-Smoot turbo-blowers, each requiring 840 hp., and capable of delivering 20,000 cu.ft. of free air per min. at a pressure of seven pounds.

The more important developments in the smeltery during 1918 were the completion of the enlargement of the No. 2 furnace from 25 ft. to 50 ft. in length, and the replacing of one of the original old converters of 10 ft. diameter and 15 ft. long by one made on the property which is 12 ft. diameter by 26 ft. long. The other blast furnace is now in process of lengthening from 25 to 50 ft. A new copper receiver was built, and a rotary driver is being installed in connection with the coal pulverizing plant, so as to make the smeltery independent of the supply of fuel oil for the nodulizers.

In the smeltery power house the present equipment of Ratteau-Battu-Smoot turbo-blowers was duplicated by the addition of one 1700-hp. 3600-r.p.m. converter turbo-blower, capable of delivering 24,000 cu. ft. of free air per min., and one 800-hp. 3600-r.p.m. blast furnace turbo-blower, which can deliver 39,000 cu.ft. of free air at a pressure of three pounds.

Two units of the new 20,000 kw. Pangal power project will be in operation before the middle of 1919. At about the time this starts, the new tailings-disposal basin and dam will be ready to receive the mill waste. This basin is at Barahona, and the flume line will be over eight miles long, with a grade of 3%. The construction of this flume line has involved driving about 12,350 ft. of tunnel, 10,000 ft. of snow-shedding, and the erection of several elaborate trestles and three suspension bridges of 276 ft. span each. Most of the work on this project has been done in 1918.

At Coya, the installed capacity of the power house has been increased from 10,000 kw. to 15,000 kw. by the installation of a fifth generating unit. During 1918 construction at the new smeltery site at Caletones was temporarily suspended, on account of the difficulty in getting supplies from the United States.

The Tacna-Arica Controversy

Toward the end of 1918 attention was directed to the smoldering political differences between Chile and Peru, which threatened to be translated into aggressive action failing an amicable settlement of the Tacna-Arica controversy. Consular representatives were withdrawn by both countries late in November. By the treaty of 1883, Peru agreed to cede the territory to Chile temporarily, provided that a plebiscite was taken after 10 years to decide the subsequent form of government. Difficulties have arisen from time to time as to the exact condition under which such a vote should be arranged. Peru demands that only those belonging to the territory concerned should be allowed to vote, and that the polls should be presided over by third and impartial persons. Chile maintains the right to extend the franchise to practically the whole population, even those residing there temporarily, and insists that the vote be taken under the direction of the Chilean authorities.

The situation is delicate, and there are a number of factors that deserve consideration. Apart from the immense deposits of sulphur that are known to exist in the Province of Tacna, the estimated wealth of the region is small. Although the district may show unsuspected potentialities as a result of future development, there are no existing indications of nitrate or other deposits. The total mineral production of the region amounts to only a small fraction of 1% of Chile's total output in this class.

Since the cession of the territory Chile has used the district to great advantage as a stepping stone to Bolivia. The Arica and La Paz Ry., completed in 1913, is already totally inadequate for the traffic available, and this fact will give an idea of the expansion that has occurred. The line is owned by the Chilean govern-

ment. Further development is expected as soon as additional equipment is available, and improvements which will facilitate traffic have already been carried out at the port of Arica. The railway has served its purpose in helping to expand Chilean interests in Bolivia, and Chile is naturally interested in the territory through which it passes.

It seems probable that the matter in dispute will be submitted to foreign arbitration. It is possible that it may be discussed at the peace conference at Paris. If this is done, it will be difficult for the conferees to overlook the circumstance that both Bolivia and Peru placed themselves unreservedly on the side of the Allies, by severing diplomatic relations with Germany, on Apr. 14, 1917, and Oct. 6, 1917, respectively. It will also be recalled that, previous to the Pacific war of 1879-1882, Bolivia possessed an outlet to the sea and the port of Antofagasta, and valuable nitrate deposits belonged to Peru. Chile, on the other hand, has, officially, maintained an attitude of neutrality throughout the Great War.

Development of the Chilean Nitrate Industry

The fact that the Great War was won with Chilean nitrate has served to attract attention to Chile's foremost industry, which has an annual value of about $150,000,000 at the port of shipment, and which brings in an annual revenue to the Chilean government of about $35,000,000. There is a vast supply of caliche awaiting beneficiation, and large amounts doubtless remain on lands that have been incompletely prospected. To these may be added the enormous tonnages of discarded residue and caliche which will certainly be available for treatment by any improved method that may be adopted. The fact that all this material contains considerable quantities of sodium nitrate will doubtless act as a further incentive for research, in connection with the utilization of modern machinery for extraction purposes.

The veil of secrecy that has so long enveloped the Gibbs process for nitrate treatment was drawn aside to a certain extent during 1918 by the appearance of a brief description of the new process.[1] From this it would seem to embody (1) wet crushing in a ball mill, (2) classification, (3) counter-current treatment of sandy product in Dorr classifiers, and (4) filtration of thickened slime in Oliver filters. Multiple-effect evaporation of the liquor has been adopted. The plant has been in operation for about a year. Results showing the actual recovery of nitrate by the new process and the cost of treatment are being awaited with interest, and it is hoped that they will be published in full detail.

Germany has produced an immense amount of synthetic nitrogen products, and her chemists may be credited with a fairly complete knowledge of the subject. It is significant that, previous to 1914, she absorbed about 25% of the Chilean output of natural nitrate, and also laid up extensive stocks. The production of the synthetic product in the United States will doubtless encourage the introduction of economies, large-scale working, and improved extraction of nitrate from the Chilean caliche, so that the natural product will be shipped at a cost to compete with the synthetic.

[1] "The Advent of Modern Mill Mechanism to Nitrate Leaching," by D. F. Irvin, *Eng. and Min. Journ.*, June 1, 1918, p. 987.

Bolivia

The high prices paid for the principal metals produced in Bolivia were a powerful stimulant to increased production. The most striking example of this has been the Cia. Estañifera de Llallagua, which raised its production from less than 1000 tons of tin concentrate per month to over 1500 tons during the first months of 1918, and is now producing about 1800 tons. This is principally due to the increase of capacity of the milling plant, which is treating 400 tons per 24 hours and will be brought up to 600 tons, making it, in all probability, the largest tin concentrator in operation. This company is now one of the most noteworthy dividend payers among mining enterprises of the world, as it probably distributed over 400% on its original capital of £425,000 in 1918.

Labor was scarce during 1918, on account of the abundant crops that were raised as a result of the exceptionally heavy rainfall; and this factor has prevented an increase in production to the extent desired and which would, under normal circumstances, have followed the establishment of high metal prices.

The Uncia mines of Señor Simón I. Patiño are now the second largest producers of tin, with about 1000 tons of concentrate per month. No change can be reported from the Huanuni mines, which belong to the same owner, as long as the new concentrator and tailing plant remain to be completed. This should require another eight to ten months.

Activity in the Colquechaca District

There has been considerable activity in the district of Colquechaca, once known for the famous wealth, in ruby-silver ore, of the Unificada mine. This mine has been idle for over 20 years on account of its lower levels being under water, but Señor Patiño has lately acquired an option on the property and will proceed to open it up again. Other old silver mines in the same district have found tin lodes on their properties, which were years ago worked only for silver, and active exploitation has started. Nearly all these mines are in or around the Cerro Hermoso, and near the old mining town of Aullagas, about three days on mule-back east of Challapata, on the Antofagasta-Bolivia railroad. If the Unificada mine and other properties develop well, there is a possibility of a railroad which is now being built by Señor Patiño from Machacamarca to Uncia being extended from Uncia to Colquechaca. Construction work, which had been suspended for four years, was resumed in August of 1918, and by next May it ought to be completed as far as Bombo, about 60 km. from Machacamarca, leaving 30 km. more to be built before it reaches Uncia.

The tin ore in the Colquechaca district is easily milled when it comes from the oxidized parts of the veins; but in nearly every instance the tin lodes, when they reach the sulphide zone, contain considerable quantities of blende and argentiferous galena. These ores require a special and complicated treatment, embodying a combination of flotation, roasting, leaching and gravity concentration, to separate the lead and silver from the tinstone. The Cia. Gallofa-Consolidada, of Sucre, is now erecting a small experimental plant, which will work along these lines.

The Austral-Bolivian Co., which operates dredges near Potosi for the recovery of tin from tailing deposits, started operations in 1918 and was apparently doing well, until one of its dredges was burnt by accident, in September. Although this is a serious setback, it will probably not impair the final success of the enterprise.

Tin Smelting in Bolivia a Failure

Two small smelteries at Potosi have been active most of the time, producing bars of about 95% tin, for which they received attractive prices during the tin famine of last summer. But under more normal conditions such operations would hardly pay. The electric furnace in La Paz has been dismantled, having proved to be a complete failure, both technically and commercially. The metal produced by the furnace was of good grade, running over 99.99%, but the slags carried about 15% tin, and they could not be resmelted at a profit. It seems that either the temperature was too high, or that too much flux was used, as the slag was altogether too glassy for a tin slag.

A Cottrell installation for precipitating fumes from a bismuth furnace at Quechisla is under construction. Electrostatic precipitation of silver fume from chloriding-roasting furnaces was considered by a few operators, but could not be adopted, owing to the difficulty of treating the fume by wet methods. During 1918 a new chloridizing-roaster of the reverberatory type was developed at Machacamarca, which makes so little flue dust, and the temperature of which is so easily controlled, that stack losses are reduced to a minimum, and a Cottrell installation will hardly be needed.

The flotation process has been introduced on a working scale into the Uncia mill, with apparent success, and is used to separate pyrite from cassiterite in high-grade middlings. It will probably be installed in the near future in both the Uncia and Llallagua mills as an auxiliary process for recovering bismuthinite, of which the ores contain appreciable quantities.

The Chilean company at Corocoro is treating with success a sulphide copper ore by the Callow process; and the Anglo-French company in the same district has just completed a new flotation plant for the same purpose, in which Minerals Separation machines are to be used.

Future Developments in Bolivia

As regards new mines, some remarkably rich deposits of tinstone and stannite have been found north of La Paz, and are being worked at a good profit by the owners. Not enough development has been done to prove whether the orebodies are large, and, even if they are, it will be a long time before these mines are opened up, because they are situated at nearly 17,000 ft. above sea level where the climate is exceedingly wet and cold, which makes it nearly impossible to obtain labor of any class. Increase in the production of tin will, for the first few years to come, hardly be from such mines as these, but will be due to improved methods of mining and milling, and work on a larger scale at the existing mines. Much will depend on the price of the metal when normal conditions are again restored.

The extension of development of tin and tungsten properties in Bolivia is foreshadowed in the announcement of the formation of an influential mining company, a subsidiary of the well-known house of W. R. Grace & Co. Bolivian tin concentrate is now being smelted in New Jersey, and it is expected that this will result in a deflection of the bulk of Bolivia's tin output from England, where it was originally shipped.

Chileans are largely interested in Bolivian industry—in copper and tin mines and in the oil fields—and regard the country as a promising field for Chile's excess productions of manufactured articles. This circumstance is a factor in the frontier trouble between Chile and Peru, because the region in dispute contains the short-route railway from the Pacific Coast to Bolivia.

The Central American Republics

A concession has been granted to a well-known firm of engineers which permits of the prospecting and development of oil deposits in Costa Rica. As an indication of the extent of the project, it may be mentioned that the concessionaires must expend not less than $20,000 within two years and $125,000 within three years, after which, and extending over a period of seven years, about $500,000 must be spent in operation and development work. A payment to the Costa Rica government on the basis of 25c. per ton of hydrocarbons extracted has been agreed upon; and both unskilled and skilled labor is to be recruited, so far as practicable, from native sources. Attention has been drawn to the gold deposits in the neighborhood of Buenos Aires and Buena Vista, and steps have been taken to carry out more systematic prospecting than has been attempted hitherto.

Interest in the manganese field in the Guanacasta section was stimulated by increased demand, although the addition in production was not maintained at the rate indicated by the expansion of operations after the first exports were made in 1916. Cost of transportation precluded any further exploitation of the coal deposits in the Talamanca region; and a similar disability will prevent the development of a number of prospects, containing copper and other minerals, which were denounced during 1918.

The two principal companies operating in the republic are the Abangarez Gold Fields, of Costa Rica, and the Aguacate Mines, Inc., and profitable operation is feasible only on account of the low wages paid to native labor.

Guatemala Develops Chrome-Ore Industry

The only gold produced in Guatemala comes from placers, and two American companies operate in this field. The larger, the Quebradas Mines Co., which took over the old placer mines of Potts and Knight, worked on an extensive scale during 1917, but continued only with a small force in 1918. The second, operating on the Rio de Las Vacas, worked with a full force until June, 1918, and then suspended operations on the death of the manager and promoter. No silver was produced, but enough lead for home consumption and for a small exportation comes from the veins of Heuhuetenango. A local company has installed a small blast furnace and made regular runs, but probably the greater part of the output is produced by Indians from small beehive furnaces. Their mines are much like gopher holes, but the veins are large, and the district is undoubtedly one of the important lead fields of the future. During 1918 the Alotepeque Zinc Mines Co. shut down on account of

high expenses and the difficulty of getting supplies from the United States.

A number of tons of mica was shipped and some of it in exceptionally large sheets. Two or three companies are operating in this field. Chromite is by far the most important mineral exported from the country. Two mines are operating and shipping, and both are controlled by the International Railways of Central America. The output of about 2500 tons of chrome oxide during 1918 will probably give an average assay of 56% Cr_2O_3. All ore was marketed in the United States. The field is a large one and offers bright hopes for the future if a good price is maintained.

Mining in Honduras was affected by the war, and a number of small properties were closed. Recently, interest is being attracted to the Departmento de Comayagua, where a silver-gold property is being opened and a hydroelectric power plant will be installed.

Brazil, Argentina, and Uruguay

Exports of manganese ore from Brazil indicate that there has been a steady expansion in this direction in recent years. During February, March, April, and the greater part of May, however, the Central Ry. would accept no manganese ore for shipment at Rio de Janiero, on account of lack of coal to run the trains, and also, possibly, because of the low rates which had been established by contract with the principal producers at an earlier date, but largely as a result of the lack of bottoms at the port of Rio, which were needed to remove the ore to importing centers. The condition was, of course, brought about by the commandeering of much of the shipping by the United States Government for war purposes. The manganese mines are nearly all situated in the State of Minas Geraes, and large outputs were recorded from the Morro de Mina property and from the Minas de Manganez de Ouro Preto.

There has been extensive development in Brazil in the production of diamonds and carbons. Platinum is known to exist in several localities in the State of Minas, but no actual steps have yet been taken for the development of the deposits. The gold and silver output is being maintained. Developments of ore at the famous Morro Velho mine of the St. John del Rey Co. are encouraging, and extensive reserves are being blocked out at a vertical depth of over 6000 ft. Troubles due to high temperatures encountered in the lower levels are being minimized by the installation of an extensive cooling and ventilating plant.

Brazil entered the ranks of pig-iron producers in 1917; and, although this industry has developed, the numerous factors which have mitigated against expansion in other countries, at a distance from the great metal markets of the world, are responsible for the fact that, comparatively speaking, little has been done toward the opening up of the vast domestic iron-ore deposits.

Wolfram Production Stimulated in Argentina

Little progress is to be reported with regard to the mineral industry of the Argentine Republic. Some expansion was noticeable, however, in connection with the mining of wolfram ores in the Province of San Luis, the output being stimulated by the war and the urgent demands of the British government. Mica, which is found in the provinces of Córdova, San Luis, and San Juan, was also produced in increased quantity. There were indications of an attempt to increase production of oil from the fields at Comodoro Rivadavia, and an output of over 100,000 tons for the first half of 1918 was reported.

As in most other countries, no railroad construction was undertaken during the period under review, and little was done to facilitate the opening up of mineral areas in many inaccessible parts of the country. There are extensive deposits of lead in the Andean cordilleras. A new company was formed in 1918 for the purpose of smelting domestic lead and Bolivian tin in Argentina.

A discovery of copper ore has been reported from Colonia, Uruguay, and it is hoped that satisfactory confirmation and development will ensue, which should reawaken interest in mining in this diminutive republic. There are gold mines in the vicinity of Cuñapiru, but work has practically been suspended for some years, following an attempt to introduce up-to-date methods of treatment by sliming and cyaniding a simple but very low-grade ore.

Colombia

The demand for platinum in 1918 stimulated activity in the working of the alluvial deposits of the Choco River and in the basins of the San Juan and Condoto rivers of Colombia. It has been estimated that the output for the year will be close to 35,000 oz., and that estimate may not be excessive.

Rumors have been current from time to time that the Chamber of Deputies of Colombia was desirous of taxing and limiting the exportation of the metal, a step which might be considered as a retaliatory measure aimed at the United States for its failure to ratify the treaty between the two republics under which $25,000,000 would be paid to Colombia in consideration of former concessions in connection with the Panama Canal scheme, but no serious attention was paid to these reports, for such a step would manifestly be contrary to the interest of Colombia itself.

Apart from the few large corporations, such as the Frontina and Bolivia Co., which operated steadily throughout 1918, the output of gold in Colombia is from small plants. Of the total, a large proportion is obtained by amalgamation treatment. In some cases the output declined, on account of the extremely high prices of supplies; but in many instances the simplicity of operations permitted the continuance of work on a small scale. For several months those operators who were able to produce under the difficulties prevailing encountered additional trouble as a result of the prevailing low exchange rate, and were unable to market their product. This condition improved, however, and recent reports indicate that the Medellin mint is able to coin all the gold produced. A number of small properties suspended operations until conditions would be more propitious. The Quindio quicksilver-mines company deferred construction of its mill. The extension of the Tolima Ry. as far as Ibague is now assured, and it is expected that the line will be completed in 1919. The realization of this project will have a potent effect on the development of the district.

Transvaal Mining in 1918

By H. F. MARRIOTT

AT THE beginning of the year 1918 the difficulties experienced by the mining industry of the Transvaal were still further increased. The profits of 16 of the low-grade mines were being reduced to vanishing point on account of the increase of costs due to the war, and a select committee was appointed to report on the conditions. The finding of the committee's report is recorded elsewhere in this review. In addition, the abnormally heavy rains of the early part of the year caused a serious setback to many of the mines on the Rand. The pumping installations were worked to their utmost capacity, and to relieve the strain it was found necessary to bring the hoisting plants into use for bailing. In consequence of this, the results of many of the mines for the first two or three months of the year were considerably below normal. The lowest levels of several of the mines of the Central Rand and the new shafts at Brakpan Mines and Daggafontein Mines were flooded.

The mines had only just recovered from this excessive rainfall when in September the epidemic of Spanish influenza extended to South Africa and speedily spread all over the Union. There were thousands of cases on the Rand, and the mortality was heavy, particularly among the natives. The returns of most of the mines were adversely affected in consequence. All these unfortunate circumstances combined to bring down the Transvaal gold output, and for these reasons the current results are not strictly comparable with those of previous years. Even at the end of the year, when hostilities had ceased, the difficulties of gold production were not in any degree lessened, and it will be many months before costs show material improvement.

Number of Producing Mines Practically Unaltered

At the end of September, 1918, there were 48 producing mines on the Rand, as against 49 in September, 1917. The Durban Roodepoort mine is worked out, and the company is being wound up. This mine has had an excellent record. It began operations in 1888, and has paid in dividends over 1200% on its capital, and a liquidation dividend is expected. Milling operations at the Glencairn Main Reef G. M. Co. ceased in November, the payable reserves being exhausted. This mine has had a moderately successful record, and was a regular dividend payer until 1915.

Twenty-eight mines paid dividends in the first half of the year, as against 35 for the corresponding period in 1917, the Consolidated Langlaagte, Durban Roodepoort, Ginsberg, Jupiter, Knights Deep, New Goch, New Heriot, and Witwatersrand Deep being those which suspended dividend payments. Springs Mines entered the list of dividend payers.

Tables I. II, and III show respectively the yield, milling capacity, and the labor position in 1918, as compared with previous years.

The problem of the maintenance of operations of the low-grade mines of the Rand was the subject of much discussion during 1918. The peculiarity of this industry. in contradistinction to all others, is that, as the price of gold is fixed, all the extra high costs have to be borne by the producer, and not by the consumer. The increase in the cost of supplies is the greatest item, but in addition to this there are increased realization charges, war bonuses to employees at home, and allowances to those on active service, and the Special War Levy. These increases have become such a burden on low-grade mines, whose margin of profit even in normal times is never high, that, unless something is done to alleviate present conditions, the cessation of work on the mines affected will result in an annual loss to the Empire of gold to the value of about £7,000,000.

At the beginning of the year a select committee was appointed by the Union government to report on this question. After hearing evidence given by representatives of the Transvaal Chamber of Mines and the chief gold producers of the country, they published their report in April. They did not recommend that help should be given by the government. They suggested that the Bank of England should reduce the insurance and freight on raw gold from 25s per £100 to 17s 6d, and that the government should remit its share of claim licenses. It was also proposed that, in the event of the low-grade mines being compelled to close, a fund should be established to continue pumping, and otherwise keep the mines in position to reopen after the war.

TABLE I. TRANSVAAL GOLD PRODUCTION

Witwatersrand District

Year	Tons Milled	Value	Value per Ton Milled, Shillings	Outside Mines, Value	Total Value for Transvaal
1884–89	1,000,000	£2,440,000	48.8	£238,231	£2,678,231
1890	730,000	1,735,491	47.4	134,154	1,869,645
1891	1,154,144	2,556,328	44.2	367,977	2,924,305
1892	1,979,354	4,297,610	43.3	243,461	4,541,071
1893	2,203,704	5,187,206	47.0	293,292	5,480,498
1894	2,830,885	6,963,100	49.2	704,052	7,667,152
1895	3,456,575	7,840,770	45.2	728,776	8,569,555
1896	4,011,697	7,864,341	39.2	739,480	8,603,821
1897	5,325,355	10,583,616	39.7	1,070,109	11,653,725
1898	7,331,446	15,141,376	41.3	1,099,254	16,240,630
1899	6,872,750	15,067,473	48.8	661,220	15,728,693
1900	459,018	1,510,131	65.8	.....	1,510,131
1901	412,006	1,014,687	49.2	81,364	1,096,151
1902	3,416,813	7,179,074	42.0	74,591	7,253,665
1903	6,105,016	12,146,307	39.8	442,941	12,589,248
1904	8,058,295	15,539,219	38.5	515,590	16,054,809
1905	11,160,422	19,991,658	35.8	810,416	20,802,074
1906	13,571,554	23,615,400	34.8	964,587	24,579,987
1907	15,523,229	26,421,837	34.0	981,901	27,403,738
1908	18,196,589	28,810,393	31.6	1,147,217	29,957,610
1909	20,543,759	29,900,359	29.1	1,025,429	30,925,788
1910	21,432,541	30,703,912	28.5	1,297,823	32,001,735
1911	23,888,258	33,543,479	28.1	1,498,006	35,041,485
1912	25,486,361	37,182,796	29.2	1,574,765	38,757,560
1913	25,628,432	35,812,605	27.8	1,545,435	37,358,040
1914	25,701,954	34,124,434	26.5	1,463,641	35,588,075
1915	28,314,579	37,264,992	26.3	1,362,469	38,627,461
1916	28,525,252	38,107,909	26.7	1,377,025	39,484,934
1917	27,251,960	37,017,633	27.1	1,306,288	38,323,921
1918 (a)	.....	.....	....	.....	36,142,591

(a) Estimated.

The opinion of the committee appeared to be that, if the low-grade mines closed, the other mines would benefit by the use of their labor, and thus keep up production. The native labor thus freed could, no doubt, be utilized, but it is questionable whether all of the white employees of the low-grade mines could be taken over by the higher-grade producers. The question remained in abeyance until July, when a representative gathering of the gold producers of the Empire was held in London, and the attention of the government was called to the urgency of the position. A government committee was appointed in October to deal with

the question, and its work is not yet concluded. Details are given herewith of three of the low-grade mines whose careers are restricted by the altered conditions.

A Few Mines Discontinued Operations

Owing to the increased costs, it was found impossible to continue milling operations at the Bantjes mine without incurring a heavy loss. It was decided, therefore, to cease crushing at the end of the year. Development will continue in the lower portion of the mine by means of an arrangement with the Consolidated Main Reef, under which an exploratory drive will be pushed forward under the present workings to connect with the Bantjes main shaft.

At the East Rand Proprietary Mines it was found necessary to abandon the southern development scheme, owing to lack of funds, the expected profit from the present mine having been absorbed in the increased costs. This great undertaking has produced nearly £25,000,000 of gold since the amalgamation of the several properties in 1908.

The serious position of the Knight Central raised the question of liquidation. The property is a difficult one to work, as it is practically cut in half by the Simmer and Jack dike. The fortunate addition to the reserves of a patch of higher-grade ore has, however, made it practicable to continue milling, and profits appear to be assured for 1919.

TABLE II. STAMPS AND TUBE MILLS IN THE RAND

	Stamps at Work	Tube Mills at Work	Duty per Stamp per Day
1909, December	9,250	148	6.8
1910, December	9,150	184	7.2
1911, December	9,565	244	7.9
1912, December	9,440	277	8.4
1913, December	9,170	278	8.7
1914, December	9,291	294	9.1
1915, December	9,495	314	9.7
1916, December	9,185	313	9.8
1917, December	9,350	333	9.9
1918, August	8,879	343	10.3

Excellent results have been attained on the Far Eastern extension of the Main Reef Leader at the Sub-Nigel mine, in the Heidelberg district. The program of expansion includes the sinking of a new five-compartment vertical shaft, and an increased treatment plant to raise the output to 30,000 tons per month within four years. The necessary capital is to be provided by creating 300,000 £1 shares. The outcrop mine, the Nigel, is worked out, and closed at the end of 1917.

City Deep Shows Excellent Cyaniding Results

The development in the South Nourse section of the Nourse Mines continues to be satisfactory, and favorable results can be expected, provided that more native labor is available. At the City Deep, Ltd., a new vertical circular shaft was started in July, to provide air and means of transport to the deeper levels. It is estimated that its depth will be 7000 ft., divided into two sections of 3500 ft. each, and it will therefore be the deepest vertical shaft in the world. The cost is estimated at £430,000, and it is expected that the shaft will be completed in 1925. The metallurgical treatment on this property was still further improved in 1918, and the loss in dissolved gold per ton of slime treated has been reduced from 6.4d to 1.9d (i.e. to under 4c per ton.)

At the Crown Mines a second circular shaft, No. 15, to deal with the large unexploited area south of the dike, has been started, and at the end of September had reached a depth of 319 ft. It is expected to cut the reef at about 5000 ft. In this section of the property, the Main Reef leader has now been exposed on the 19th level south of the dike, with a value of 84 dwt. over a reef width of eight inches, thus confirming the high values previously shown in the vicinity by a borehole.

The seven-compartment rectangular shaft in the Booysens area cut the reef at a depth of 4148 ft., and was connected by a crosscut with the Robinson Deep mine during 1918.

A new circular shaft is being sunk at the Durban Roodepoort Deep about 400 ft. from the southern boundary. Its depth will be about 3000 ft., and the equipped cost is estimated at £182,500. This shaft will eventually deal with all the tonnage hoisted from the mine. At the Witwatersrand Deep good ore has been exposed in the bottom of the mine, averaging 11.4 dwt. over a stope width of 50 inches.

Earth tremors continued during 1918 in some of the mines of the Central Rand, owing to the extension of the worked-out areas, the chief being the Village Main Reef and the Ferreira Deep. The most severe shocks were those of July and August, in the Village Main Reef. This mine, being nearly worked out, contains large unsupported areas, which are readily affected.

The address of the president of the Institution of Mining and Metallurgy included the total results of the gold contents of the Main Reef Leader as disclosed by the workings of the Central Rand over a distance on the strike of eight miles. The average assay values per ton for succeeding depths on the reef of 1500 ft. each to a total of 9000 ft. were 44.7s, 31.2s, 37.1s 32.4s, 29.8s, and 30.6s. These figures are important as bearing on the continued stability of the Rand banket deposit as a gold producer, and as comprehensive evidence on the general question of the continuation of values at depth.

Far Eastern Rand

In 1917 the government decided against mining operations being conducted directly by the state, and therefore a Mining Leases Bill to deal with the areas still under state control was passed early in 1918. The law established a Mining Leases Board, the members of which are Sir Robert Kotze, government mining engineer; H. E. Farrer, the Secretary of Finance; F. E. Kantback, Director of Irrigation, and Sir William Hoy, the general manager of the South African Railways. It also fixes the maximum and minimum scales for the government's share in profits, and makes provision for larger mynpachts (mine leases).

The 2235 claims on the west section of the Farm de Rietfontein, No. 14, which were put up for tender in June, 1917, but were unallotted, were offered again for tender early in 1918. The tenders received by the government were from the Anglo-American Corporation, the Central Mining and Investment Corporation, and the General Mining and Finance Corporation. The result was announced on Mar. 21, and that of the Anglo-American Corporation was accepted. A new company has been formed to deal with the ground under a title of West Springs, Ltd., with a capital of £1,400,000 in £1 shares, to be issued at par.

Springs Mines, Ltd., will grant facilities for begin-

ning development from its property pending the sinking of the two shafts arranged for. In return for this accommodation it has been given an option over a block of reserve shares. The technical management is in the hands of the Consolidated Mines Selection.

New State Areas and Springs Mines

The lease of the 2050 claims on Farm de Springs acquired last year by the Johannesburg Consolidated Investment Corporation was transferred at the end of February, 1918, to a new company registered as New State Areas, Ltd. Two vertical shafts are to be sunk forthwith, and it is estimated that the reef will be cut at about 3600 feet.

In 1917 Springs Mines obtained an extension to its property of 2235 claims on the eastern section of the Farm de Rietfontein, No. 14. A new shaft has been started, which, it is estimated, will be sunk to a depth of about 4000 ft., and should be completed in about four years. In the meantime, development is being pushed from the present mine into the new area, with a view to obtaining an early production of ore therefrom. The capacity of the reduction plant is to be immediately increased from 30,000 to 40,000 tons per month. Its eventual capacity is placed at 1,400,000 tons per annum, This, however, cannot come into operation for several years. At Modderfontein East, Ltd., which is still in the development stage, the comprehensive program for opening up the reef throughout the property is proceeding. At the end of September the two new shafts, Nos. 2 and 3, were, respectively, 898 ft. and 818 ft. in depth. The deep-level area is being rapidly developed from the Cloverfield shaft, and an exploratory drive has entered the outcrop section from Modderfontein B Mine.

Francois Cementation Process Used by Brakpan Company

At the Brakpan Mines the two new deep-level shafts, Nos. 3 and 4, in the extension of the property acquired in 1917, are being sunk. Their final depths are estimated at 4200 ft. and 4500 ft., respectively. Water in quantity has been encountered in No. 3 shaft, and the François cementation process is being employed to seal it off.

The new plant of the New Modderfontein Gold Mining Co., which increases the mill capacity to 100,000 tons per month, began operations in April, 1918, and is rapidly increasing its output to full production. The duty of the Nissen stamps in the new mill is 27 tons per day, with 0.28-in. screen aperture. The treatment plant includes many improvements on previous practice.

In July the extension of the reduction plant of the Modderfontein B, Ltd., to treat 60,000 tons per month, was completed. The delays in this work were due to the shortage of suitable labor. The Government Gold-Mining Areas brought up its capacity to 135,000 tons per month by the addition of five new tube mills and an extension to the Butters slime plant. Ten extra stamps and a new tube mill were added at the Van Ryn Deep on July 1.

The centralized control under the Transvaal Chamber of Mines of all mining supplies for all the mines has worked satisfactorily. The pooling system was originally restricted to gold, coal, and diamond mines, but in March, 1918, it was found advisable to include the base-metal mines to enable these to obtain supplies.

Introduction of Economies Has Helped To Make Operation Successful

Following on the enforced reduction of imports of mining supplies, the requirements of the mines have been met to a considerable extent by working up scrap and second-hand material locally. In this way economies have been introduced which should have a lasting effect. These include reshanking shoes, making cam shafts of broken stems, making up drill steel and rock-drill parts from scrap, shortening boiler shells to make further use of the tubes, and lining bins and repairing truck bodies with flattened-out railway sleepers.

Many mines now make their own tools from scrap material at a reduced cost. Owing to the necessity for restricting the use of glycerin in explosives to the lowest consumption possible, new compounds have been produced to take the place of gelignite. These include sengite, the ingredients of which are gun-cotton and nitrate of soda, and amatol, containing ammonium nitrate. The results from the use of these substitutes have been satisfactory.

Welfare Work Among Natives Effective

With regard to the health of the native workers on the mines, further experiments have been made with Dr. Lister's anti-pneumococcal vaccine, and the results have been extremely successful. At the Premier diamond mine the number of cases of pneumonia per 1000 natives employed during 1917 was 4.7, this being by far the lowest record obtained. The highest was 153 per 1000, in 1910. Experiments have also been continued at the Crown Mines, with the result that the number of cases has been considerably reduced. As the shortage of native labor is one of the greatest difficulties with which the mines now have to contend, it now rests with the government to recognize the success of this preventive of the disease, and to sanction a return to the employment of tropical natives.

TABLE III. LABOR EMPLOYED IN TRANSVAAL GOLD MINES

	Whites	Natives	Native Death Rate per 1000
1910	25,376	191,784	35.72
1911	25,108	194,286	34.04
1912	24,334	206,121	28.83
1913	22,797	162,181	26.61
1914	21,834	177,291	18.35
1915	22,910	222,735	19.87
1916	23,074	206,852	17.17
1917	22,993	182,652	13.62
1918, January	22,921	185,864	
March	23,097	195,042	13.49 (a)
May	23,393	193,025	
August	23,422	189,295	

(a) For 12 months ended August, 1918.

In regard to miners' phthisis a Further Amendment Bill was passed in June, dealing chiefly with the extension of the period during which compensation is paid, and also with increases of pay to dependents. There are now four acts in existence dealing with this question, and it is proposed as soon as possible to bring in a final bill amalgamating them.

Industrial Relations Show Improvement

The year 1918 witnessed considerable improvement in the relations between employers and employed. The system of boards of reference, on which both sides are equally represented, has been extended to include all

the men's unions. This advance is of the greatest importance, and is proving a satisfactory method of settling disputes. In July the mine mechanics asked for an increase in wages. They, however, have realized the necessity of adjusting their demands to the industrial position and the consequences involved in the closing of 16 of the low-grade mines, which is likely to take place if there is a further rise in costs.

Diamonds and Base Metals

The position of the diamond industry was well maintained in 1918. In the half year ended June 30, the Transvaal output was 446,411 carats, as against 491,410 carats for the first half of 1917. Of this total the Pretoria district produced 412,900 carats.

The iron-ore deposits near Pretoria and Ermelo were the object of much interest during 1918. Smelteries have been erected, and operations are being carried out on a small scale. The works erected to deal with the ores from the Pretoria district include a 50-ft. blast furnace capable of producing between 10 and 15 tons of pig iron per day. The ore from the Ermelo deposit is sent to the furnaces at Vereeniging, from which the production is sufficient to keep the greater part of the industry supplied with shoes and dies.

At the Rooiberg tin mine there was an improvement in results during the latter part of 1918. On the new property on Farm Blaauwbank payable ore is being opened up in several places, and the outlook appears promising. Better results have also been obtained at the Zaaiplaats tin mine, and in July a dividend of 30% was declared. The company has acquired on option from the Transvaal Consolidated Land Co. 27.75 acres of the adjoining farms Groenfontein and Roodepoort, which area contains a large quantity of high-grade alluvium. Tin smelting has begun on a small scale.

The development results of the Messina Copper Co. for 1918 have been disappointing, and the company has been greatly handicapped by the lack of labor and shipping facilities.

Australasia in 1918

By W. P. GEARY*

IN AUSTRALIA metalliferous mining was in a prosperous condition in 1918, and although it is not yet possible to obtain the output of the various metals accurately, the aggregate value of the mineral production during the year will closely approximate, if it does not exceed, that recorded for the previous year.

During the latter part of the year it was announced by the federal government that the exportable annual output of zinc concentrates, 300,000 tons, had been sold to the imperial authorities for the period of the war and 10 years afterward, and also that the exportable output of lead, about 175,000 tons per annum, had been sold to the British Ministry of Munitions, with the exception of lead for the markets of the East. It was also announced by the government that it would finance the copper producers for a period of three months from Jan. 1, 1919, if it should prove impossible to arrange an extension of the present contract with the British government to cover the output beyond the end of 1918. These considerations should prove important factors in maintaining the production of the industrial metals during 1919.

Gold Production

During the period under review every district in Australia showed a decline in the output of gold, and it is clear that unless fresh discoveries are made, the position of the industry will be unsatisfactory. To stimulate production the vital importance of granting a bonus of £1 ($5) per oz. on all gold produced within the empire, has been urged upon the imperial government, and also the suspension of all taxation on gold mining by the imperial and dominion governments.

Table I shows the gold yield of Australia for 1917 and 1918, the figures for 1918 being estimated from the production for the first 10 months of the year. Western Australia still maintains its position as the chief producer, but the yield indicates a falling off when compared with the year 1917.

In Victoria an important event was the completion of negotiations by the Bendigo A-1 Gold Mines, Ltd., with the Bendigo Amalgamated Co. to take over the Clarence United, New Argus, New Moon, and Suffolk United mines. The government has agreed to advance the company £10,000, which must be spent in actual development work, provided the company first expends a similar sum. It is expected that by persistent work a sufficient number of new shoots will be opened to permit of the tonnage being increased from 8000 to 8500 tons per fortnight. The last report available shows that 146,769 tons, averaging 5100 tons per fortnight, was treated, for a yield of 41,130 ounces.

TABLE I. GOLD PRODUCED IN AUSTRALIA IN 1917 AND 1918

	Fine Oz., 1917	Fine Oz., 1918
Western Australia	970,317	887,966
Victoria	201,872	159,704
Queensland	179,305	136,629
New South Wales	82,171	84,137
Tasmania	14,496	13,500
South Australia	7,145	8,000
Totals	1,455,306	1,289,936 (a)

(a) Estimated.

The Mount Morgan Gold Mining Co., Queensland, for the year ended June 2, 1918, treated 214,989 tons of ore and produced 83,567 tons of concentrates. The smeltery and refinery made an output of 7619 tons of refined copper and 86,219 oz. of gold. The ore reserves at the date of the issuance of the report (June 2) were estimated at 3,825,685 tons, as compared with 3,942,029 tons on Nov. 25, 1917. The grade of the reserves is practically stationary at 2.58% copper.

In New South Wales it is expected that the total yield for 1918 will show a slight advance on that recorded for the preceding year. This is in a measure due to the resumption of milling operations by the Mount Boppy Gold Mining Co. at the end of January, 1918. The yield from this company's mine for the first three

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months of the year totaled 5369 oz. of gold, the ore reserves being estimated at 249,334 tons, which, without reckoning future developments, would give the mine, under favorable conditions, a further life of at least three and one-half years.

In Tasmania the Tasmanian Gold Mining Co. during the 12 months ended Mar. 25 treated 19,190 tons of concentrates and slimes, from which was recovered 5861 oz. of fine gold, valued at $123,825.

The mines in the Broken Hill field (N. S. W.) continued production on a satisfactory scale during 1918. The output for the first nine months of the year was as follows: Lead concentrates, 202,805 tons; zinc concentrates, 269,271 tons, and carbonate ore, 25,093 tons.

The North Broken Hill Co. during the half year ended June 30, 1918, raised 106,489 tons of ore, and the classification effected by the mills is given in Table II. The assets at the above date show a surplus over liabilities of $2,999,250.

TABLE II. NORTH BROKEN HILL PRODUCTION, JANUARY-JUNE, 1918

Product	Net Weight, Tons	Proportion, %	Assay Value Pb, %	Ag, Oz.	Zn, %
Concentrate	20,605	18.8	65.2	24.1	7.7
Quartzose tailing	15,800	14.5	2.7	2.6	8.0
Zinc tailing	57,778	52.9	3.3	3.5	16.2
Slime	15,017	13.8	6.3	4.9	15.8
Crude ore	109,200	100.0	15.3	7.5	13.4

The Broken Hill South Silver Mining Co. mined 127,745 tons of sulphide ore during the six months ended June 30, 1918. The working account shows mine production, $2,131,525, and a balance carried to profit and loss of $1,084,425. This, with $1,587,765 brought forward, and $51,715 interest and dividends, makes a total of $2,723,905.

The output of the Broken Hill Proprietary Co.'s mine for the half year ended May 31, 1918, was 79,348 tons, or an increase of 24,032 tons over the previous six months. The plants handled 70,843 tons of sulphide ore, which yielded 11,958 tons of lead concentrates, assaying 60.55% lead, 29.14 oz. silver per ton, and 13,608 tons of slimes. The zinc flotation plant dealt with 144,944 tons of tailings, as compared with 92,907 tons for the previous half year, the production of zinc concentrates amounting to 36,630 tons. The net profit for the half year was $1,798,530, as compared with $1,454,405 for the preceding six months. After providing for all outstanding liabilities, there remain liquid assets in cash, bullion, and convertible stocks representing a total value of $4,227,730.

The operations of the Zinc Corporation, Broken Hill, for 1917 show that the mine owned by this company produced 134,618 tons of ore, assaying 8.5% zinc, 2.8 oz. silver, and 14% lead. The yield is reported as follows:

	Tons	Zn, %	Ag, Oz.	Pb, %
Lead concentrates	24,829	6.6	10.2	64.4
Zinc middlings	40,576	16.6	1.9	4.7
Residue	69,213	4.4	0.6	1.4

The zinc concentrator treated 257,590 tons (215,640 tons being drawn from the dumps), of an average assay value of 14.6% zinc, 6.6 oz. silver, and 5.6% lead, which resulted as follows:

	Tons	Zn, %	Ag, Oz.	Pb, %
Zinc concentrates	63,700	47.7	10.9	6.9
Lead concentrates	7,164	15.6	30.2	56.7
Zinc slime	7,306	37.2	26.0	14.1
Residue	179,420	1.8	3.4	2.8

The net profit was $1,125,770, and the total available, after including the balance brought forward, was $1,255,625.

In the State of Queensland the value of the mineral production, other than gold, coal, and precious stones, for the first nine months of 1918, was $10,057,380, as against $9,438,670 for the similar period in 1917. The output of silver and lead was valued at $109,130. The quantity of silver-lead ore produced in Tasmania during the year 1917 was 9576 tons, valued at $760,610, and for the first six months of 1918 was 2516 tons, valued at $218,115.

Production of Tin

In New South Wales, the Vegetable Creek Tin Mining Co., Emmaville, continued working on rich wash in the dip workings, where, in the crosscut, there is a width of 36 in. which carries 200 lb. per fathom. The usual output of six tons of oxide per week is being maintained. The production for the year ended Apr. 24, 1918, was 204 tons, valued at $186,135. The Water Co., Emmaville, during the half year ended July 31, sluiced 296,300 cu.yd. of material, for a yield of 83 tons of black tin. Since the inception of operations, 12 years ago, the company has sluiced 4,695,000 cu.yd. of material, for a yield of 2384 tons of black tin, averaging 1.138 lb. per yard. For the first six months of 1918 it was estimated that the value of the yield from the Ardlethan field was approximately $200,000, of which the Bygooend had contributed $50,000.

The Mount Bischoff Tin Mining Co., Tasmania, for the half year ended June 30, treated 44,041 tons of ore, for a yield of 226 tons of concentrate. The ore reserves are about 1,185,000 tons, of an average assay content of 0.29% tin. At the smelting works 1859 tons was smelted, for a yield of 1269 tons of tin. The quantity treated on behalf of the company was 237 tons of oxide, which yielded 143 tons of tin, the remainder being on custom ore.

The Briseis Tin Mining Co., Tasmania, according to the last report, made a profit of $144,830 for the year 1917, as against $162,585 for 1916. The output of tin was 339 tons, as compared with 466 tons in the previous year. The Pioneer Tin Mining Co., Tasmania, including the Argonaut and South Pioneer properties, for the year ended June 30, 1918, treated 826,500 cu.yd. of material, for a recovery of 345 tons of stream tin. Since 1900 about 10,053,300 cu.yd. of material has been treated, yielding 7009 tons, or 1.562 lb. per cubic yard.

In the State of Queensland the output of tin for the first nine months of 1918 totaled 895 tons, valued at $953,615. In Western Australia, tin to the value of $185,535 was produced in 1917. The production of tin ore in Tasmania for the first six months of 1918 totaled 951 tons, valued at $1,030,355.

Australian Copper Production in 1918

It may be expected that the copper production of the commonwealth for 1918 will approximate 32,500 long tons, which shows a slight falling off. Of this total, 50% will, as usual, be contributed by Queensland, and the remainder, with the exception of about 1000 tons which may be credited to Western Austraila and Papua, will be the production in about equal proportions by New South Wales, South Australia, and Tasmania.

Copper producers during 1918 had a difficult time. The price fixed for electrolytic, £108, and fire refined, £106, by the British Munitions Committee would have been entirely satisfactory had it been maintained for a year, but, on each occasion that the price was settled, it was done in such a way that producers had only a three months' tenure. This hampered financing operations seriously, and put the small producer practically out of action. At the time of writing those who have been able to make financial arrangements to continue, have no market for current production.

The British munitions contract expired Dec. 31, and, now that peace is in sight, there seems little prospect of a renewal unless the Allied governments realize that for economic reasons they must stand behind current production until the freedom of trade is mutually established again. The Australian production up to Sept. 30 is cared for; anything coming to the refinery after that date will not be in the refined state in time for inclusion in the British government contract. Consequently, the companies producing blister today are waiting to see what will be done for them in England. It would seem as if the peace discussion will relegate the question of copper production to obscurity for a while.

On this side of the world it is maintained that the Allied governments should finance the copper production during the peace discussion period, and take the copper for joint account. It could be sold in due course at cost price plus interest and charges to those governments which have caused the war.

Queensland has maintained in copper its premier position, largely through the production of Hampden Cloncurry and Mount Morgan. Of the Queensland mines it may be said that only these two have been able to make any showing against the adverse conditions referred to. Mount Elliott and Mount Cuthbert have at intervals had a short run, but the sum total is small. The old-established Wallaroo & Moonta, in South Australia, accounts for practically all that this state brings into the figures. In a labor sense Wallaroo & Moonta is well off. It is a settled town, and the company has been able to work amicably with its employees, whose wages vary with the price of the metal.

The Mount Lyell Co., the principal producer of Tasmania, has suffered principally through shortage of labor. Like Mount Morgan, in Queensland, it has adopted mechanical concentration, and at present is watching carefully the development of leaching in the United States.

Great Cobar and C. S. A. have been the principal producers of New South Wales. The latter has been given rail connection, and has entered upon a profitable career. Mount Hope, Ltd., another big proposition out in the west, has just been connected by rail. It has a future ahead of it, but during 1918 was twice compelled to cease mining, because of shortage of water. The trouble is not insurmountable, and the company is remedying the situation.

Papua continues to open up some promising basic deposits. It, however, adds little to total production, as work is mostly restricted to development. Western Australian operations have been mostly confined to the mining of shipping-grade ore, which has been sent to Port Kembla, the refinery in New South Wales, for smelting and refining. Whim Well, in the northwest, has been the largest producer. The West Australian production has been somewhat increased by the operations of the government smeltery at Phillips River.

Mica in 1918

Because of its wide range of utility in electrical equipment, mica was considered in 1918 as an essential war mineral. Restrictions imposed on the importation of mica on account of the lack of shipping caused some anxiety, because domestic production, so far, has not proved equal to consumption. Sheet mica, imported from India, is considered especially valuable because of its desirable physical properties.

The statement contained in *Mineral Resources* that the domestic production of sheet mica in 1917 was 1,216,816 lb., about 40% of the total consumption, gives no information as to its quality. The imports consist largely of clear sheets of good quality, whereas the domestic product includes several varieties. The prices of the larger sheets, 58c. per lb., were slightly lower than for the preceding two years, but an increase of 10 to 20% in price occurred in some of the smaller sizes.

During 1918 mica was imported chiefly from China, India, and England, with smaller quantities from Brazil, Peru, Guatemala, and Mexico. The more important domestic sources of production were North Carolina, New Hampshire and South Dakota, with varying quantities from Alabama, Georgia, Idaho, South Carolina, and Virginia. The total value of the domestic mica produced in 1917, according to the U. S. Geological Survey, was $757,346, and the value of the imported mica reached $1,430,048. The domestic production in 1918 increased proportionally to the total consumption. From foreign countries, only the sheet mica is exported. In the United States the chief domestic product is scrap.

A comparison of the quantity of crude and manufactured mica imported into the United States for the first nine months in 1917 and 1918, according to the Bureau of Foreign and Domestic Commerce, is given in the accompanying table.

U. S. IMPORTS OF CRUDE AND MANUFACTURED MICA, FOR NINE MONTHS OF 1917 AND 1918

	1917		1918	
	Imports, Lb.	Value	Imports, Lb.	Value
Unmanufactured	639,291	$318,653	557,556	$495,079
Cut, split and manufactured	.....	804,625	.....	753,023

Chinese Tungsten Ore Industry

The deposits of tungsten ore in South China, including Hongkong, have become one of the most important additions to the world's supply of this ore. The shipments of ore from Hongkong alone, in addition to those from Canton, Swatow, and other points made through Shanghai and other transshipment ports, during the first eight months of 1918, were valued at $1,010,405 gold. The number of Chinese interests involved in the collection of the ore from Kwangtung, Kwangsi, and Hunan has increased until there was a veritable boom in the business, says the *Ironmonger*. The ore is generally found in pockets scattered over a wide extent of territory. At present the greater part of it is purchased by middlemen from Chinese operators who manage the mining and deliver the ore.

Uncommon Ores and Metals

By H. C. MEYER*

NO DATA are available as to the total production of cerium, or cerium mixed, metal, as it is known to the trade, during 1918. This material, which is a complex alloy of cerium, lanthanum, didymium, and other metals of the cerium and yttrium group, is produced mainly from monazite sand residues by electrolytic methods. Its chief use is in the manufacture of ferrocerium, which is employed as a tinder in pocket cigar lighters, gas lighters, and to a large extent during the last three years for military purposes. The production of this alloy probably runs into 1000 to 2000 lb. per month. Prior to 1917, the alloy was manufactured under Austrian patents, but, following the seizure of these patent rights by the Alien Custodian, licenses were granted to several American manufacturers to produce the metal, and, as a result, the greatly inflated price took a severe drop. During 1916 the price was $25 per lb. but in the late spring of 1917 the market dropped to $18 or $20 for moderate-sized lots, with slightly lower figures for large quantities under contract. Ferrocerium is an alloy consisting of, approximately, 30% iron and 70% cerium, with lanthanum, didymium, and other ingredients.

Palladium

The active demands for palladium as a substitute for platinum increased greatly as the restrictions on platinum, except for Government work, became more and more severe. At the beginning of 1918 the price was about $135 per troy ounce, and by the middle of the year this price had advanced to as high as $165. It became apparent that it would be necessary to control the price of this metal as well as that of platinum and iridium, and the War Industries Board announced that the maximum price should not be in excess of $135 per troy ounce, and that trading in the metal, except for war purposes, could be conducted only under a license. After the signing of the armistice and the removal of Government control, the market advanced slightly, but only for a brief period; and before the close of the year, offerings were made of good-sized parcels for as low as $125 per troy ounce. It is interesting to note that, prior to 1914, palladium was used only in comparatively small quantities and considered a very rare metal. With the advent, however, of gold-palladium alloys for dental work and the manufacture of crucibles, the production of this precious metal showed a marked increase. In 1915 the total number of troy ounces sold amounted to only 958, whereas in 1917 the amount was over 3300. The probabilities are that the production for 1918 will show at least a 75% advance over that of the previous year. The uses of this metal have become so firmly established in certain trades that it is unlikely that a return will be made to the use of platinum, unless there is a marked drop in the price of the latter.

Selenium

The chief use of selenium during 1918 appears to have been as a decolorizer for glass as well as in the manufacture of ruby glass. The former use was developed through the shortage of suitable grades of manganese, which heretofore has been used to mask the green color imparted by the presence of iron. The demand of glass makers became so great that producers were not able to keep up with the consumption, and the price rose to as high as $3.25 per lb. and remained around this figure throughout the year. During the last quarter, however, there was a slight recession in price, and, at the close of 1918, black, powdered, amorphous selenium was offered for as low as $2.75 per pound.

Strontium Ore

The market for both celestite (the sulphate) and strontianite (the carbonate) was comparatively quiet. Large deposits of apparently high-grade carbonate were discovered at several points in the West and sold in carload lots at the rate of $60 to $80 per ton, depending on the purity of the ore. Nearly all the sulphate consumed was imported, as most of the mines in this country are situated in the Far West, and the high transcontinental freight rates made it impossible for domestic producers to compete with the high-grade imported ore which is laid down on the Atlantic seaboard at prices ranging from $16 to $18 per gross ton. The chief demand for strontium ore is in the manufacture of strontium nitrate, large quantities of which were used for military purposes, in signal rockets, star bombs, and similar apparatus. There was practically no fluctuation in the price of strontium nitrate—about 25c. per lb. throughout 1918.

Thorium Ore

The importations of thorium ore in the form of monazite sand from Brazil and India were practically normal during 1918. The Brazilian sand carries an average of 6% thorium oxide, and is preferred by certain manufacturers of thorium nitrate to the Indian sand, which carries an average of 8% thorium oxide. Prior to 1914 the Indian deposits as well as those of Brazil were practically controlled by German interests, and nearly all the thorium nitrate was manufactured in Germany and Austria. Under the control of the German syndicate the price of the nitrate was so regulated that French, English, and American independent manufacturers were practically driven out of business. The German syndicate had large mantle factories in all of the above-named countries, which served to further strengthen its strangle hold on the market. The war, however, put an end to all these conditions, and several independent manufacturers are now supplying consumers with thorium nitrate equal in quality to the best Austrian or German nitrate. There was little or no fluctuation in price in 1918. During the first half, the price ranged from $6 to $6.50 per lb., with lower prices for yearly contracts. Toward the end of the year, owing to keen bidding among nitrate manufacturers for the 1919 requirements of the mantle trade, the price dropped to $5 and $5.25 per lb., according to quantity. The world's consumption of thorium ore is approximately 3000 tons per annum. The consumption in all countries of incandescent mantles is about 300,000,000, and the average mantle contains the equivalent of about 1 gm. of thorium nitrate.

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Titanium

Like many of the other war minerals, titanium ore was in great demand during 1918. The absence of any important domestic production of rutile, coupled with the inability to import this mineral from Norway, compelled manufacturers of ferrotitanium to resort to ilmenite, which, although carrying a lower titanium content than rutile, is just as suitable for the manufacture of the ferro-alloy as high-grade material. The beach deposits of ilmenite sand on the east coast of Florida supplied most of the demand, although a quantity of ilmenite ore was imported from Canada. Ilmenite sells for $12 to $20 per ton in carload lots, and generally carries from 35 to 45% titanium oxide. Little rutile was offered. The Norwegian grade was selling abroad for as much as $400 per ton during the first half of 1918. Later, owing to improvement in shipping conditions, the imported grade was offered in carload lots here for much lower figures. Prepared grades of titanium oxide, sold under the trade name of "titanellow," were in active demand for ceramic purposes. The price of "titanellow" ranged from 50c. per lb. for the lower grades, suitable only for pottery work, up to much higher figures for the highest grades used in porcelain teeth.

Uranium

There was only a small production of carnotite during 1918, and ore carrying 1½% to 2% uranium oxide sold for $50 per unit, or $75 to $100 per ton, in carload lots. The black oxide, used principally in the manufacture of ferro-uranium and uranium salts, was quoted at from $3.25 to $3.60 per lb., depending on quantity. Sodium uranate, or, as is known in the trade, yellow oxide of uranium, ranged in price from $2.25 to $2.50 per lb. The great future for uranium apparently lies in its use as a steel-hardening agent. Although there has been much prejudice against ferro-uranium, the results obtained by many tool manufacturers and users of high-speed steel show that it has real merit; and it is probably only a question of time when it will be just as largely used as ferrotungsten and ferromolybdenum.

Zirconium

The year 1918 witnessed an unprecedented demand for zirkite—the commonly accepted trade name for native zirconium oxide. The total amount of zirkite imported during 1918 was approximately 1400 gross tons. This ore carries from 75% to 80% zirconium dioxide. During the first quarter the demand for the ore was mainly for refractory purposes, as it has been shown to be of great value for electric-furnace linings, as well as for other purposes where a refractory having a low coefficient of expansion, high melting point, and maximum resistance to slag corrosion is demanded. It had been known prior to our entry into the war that the Germans had developed remarkable zirconium steel, which was claimed to be superior to vanadium, chromium, molybdenum, tungsten or nickel steel. The demand for light armor plate on tanks, aeroplanes, and other equipment, compelled the Government to investigate the possibilities of all steel-hardening elements for such purposes, and it was ultimately decided that zirconium was the best suited for the requirements of the War Department. Owing to the absence of any authoritative technical data on the production and uses of ferrozirconium, many difficulties were encountered, but ultimately through the efforts of several large manufacturers of ferro-alloys, a ferrozirconium suitable for the production of zirconium steel was evolved. Ferrozirconium, as now offered to the trade, carries approximately 30% to 36% zirconium metal and sells for $4 to $4.50 per lb. of contained metal, depending on the quantity demanded. It is not to be supposed that ferrozirconium will supplant ferrotungsten, ferrochromium or ferrovanadium, but it seems evident that it will be largely in demand for certain purposes for which these other ferro-alloys are not entirely satisfactory.

Lump metallurgical zirkite sold for 5c. to 7c. and ground for 6c. to 8c. per lb., depending on quantity. Zirkite cement for chemical purposes and as a bond for zirkite refractories sold at 8c. to 10c. per lb., according to the quantity demanded.

The demand for zirkite bricks was active throughout 1918, increasing toward the closing months. All the standard brick shapes required by the trade are now available, and the use of this new basic refractory is well past the experimental stage. A standard 9-in. zirkite "straight" weighs approximately 12 lb. and sells in carload lots at prices comparing favorably with magnesite brick, when life and efficiency are considered.

Potash in 1918

Concerted efforts on the part of the Government and various producers in 1918 resulted in increasing the production of potash to only about 60,000 short tons, approximately of pure K_2O, the 1917 output having been 32,573 short tons, according to figures of various Government bureaus. With normal pre-war needs estimated at about 240,000 short tons, the output in 1918 thus rose to only 25% of this amount, from 13% in 1917.

The average selling price at point of shipment in 1917 was $4.26 a unit, or $426 a ton pure K_2O, according to figures reported to the U. S. Geological Survey by the 82 firms then producing, most of whom were small wood-ash leachers. At the beginning of 1918, the price was approximately $300 a ton, and at the end of the year about $1.50 a unit, or $150 a ton. During the latter half of 1918, it is understood that fertilizer men, the chief consumers of potash, were out of the market completely, being unwilling to pay the price asked, the prospects appearing good of obtaining foreign potash within a comparatively short time at a much lower figure.

The chief sources of the 1918 potash supply, briefly, according to A. W. Stockett, of the U. S. Bureau of Mines, were: Natural brines from Nebraska lakes, four companies operating; Searles Lake, California, two companies operating, namely, the American Trona Corporation and the Pacific Coast Borax Co. Solvay Process Co.; Salduro salt marsh, Utah, Solvay Process Co.; alunite deposits, Marysvale, Utah, chief producer being the Mineral Products Corporation; cement works, two companies producing at beginning of 1918; and California kelp, Hercules Powder Co., chief producer. Potash was also produced from glauconite at Jones Point, N. Y., and Stockertown, Penn., and from other minor sources.

Efforts of the U. S. Bureau of Mines to induce cement plants to undertake the recovery of potash were hindered by the curtailment of building operations and by transportation difficulties, which caused many companies to shut down or to reduce their scale of operations. On the other hand, the increased activity of blast furnaces made possible greater experimentation in the matter of the recovery of potash.

Blast-furnace dust was thought by some interested to be a possible source of potash, though there were no developments in this direction. It was expected that a dozen cement companies would have been producing potash by the end of 1918. The doubtful future and the uncertainty as to war-profits taxation probably retarded many projects. It was announced early in the year that the Du Pont Nitrate Co. had produced potash commercially from Chilean nitrate and had revealed its process to non-enemy competitors.

The first permit for leasing potash lands under the act of Oct. 2, 1917, was issued on Feb. 2, 1918, by the Secretary of the Interior, to cover 2560 acres in Inyo County, Calif. The production of potash was to have been stimulated, with that of other war minerals, by the War-Minerals Act., of Oct. 5, 1918. In October, the War Industries Board began a potash survey, with a view to meeting agricultural needs, there being no shortage for military needs. After the armistice was signed, the problem of increasing potash production in the United States was turned over to the Department of the Interior by the chemicals division of the War Industries Board.

Domestic potash produced at high cost would therefore seem to stand little chance in competition with the foreign product. Possible exceptions are such companies as may be operating in the Far West at moderate cost, and which can establish a near-by market.

Talc and Soapstone in 1918

The demand for talc in 1918 was greater than in previous years, owing to the shortage of French and Italian talcs, and, in some cases, to inability to procure English china clay, used to some extent as a substitute, although an added quantity of the domestic talc has supplanted that product which was formerly imported from Italy and France. A number of cotton-cloth manufacturers who formerly used nothing but an imported talc have found certain domestic grades satisfactory, and it is expected that many of them will continue their use even when importations resume their normal conditions and prices are low. Several large paper mills manufacturing fine grades of book and writing papers are using domestic talc, and it is expected that they will continue to do so regardless of the future importation of English china clay. The use of talc has increased in the manufacture of rubber and prepared roofing, and there is every indication that the demand for enlarged amounts will continue.

Owing to the fact that the talc industry is still in its infancy, many improvements have been made in separating the pulverized product, and it is because of this fact that paper and other manufacturers are becoming more interested in domestic talcs. Though no new processes of preparing talc for the market were developed in 1918, those already in vogue have been so standardized and refined that some producers have succeeded in obtaining a superior product, particularly during the last two years.

Labor conditions were generally unsatisfactory during 1918, but the shortage has not been such as to occasion protracted shut-downs among the talc manufacturers, although the irregularity of labor has at times seriously interfered with production, and in the early part of 1918 some of the mills were closed, owing chiefly to car shortage, which made it impossible for them to market their product.

It is expected that final production figures for 1918 will show an increase over those for 1917, which were 198,613 tons, valued at $1,889,672, or an average of $9.51 per ton. During 1918, the production of magnesia talc in New England was about 78,000 tons, an increase of 5% over figures previously reported and an increase of nearly 15% over the production in 1915.

Prices advanced in 1918 from 12 to 20% above those in 1917 and varied with the different grades. The highest average-priced grades ranged from $60 to $240 a ton and the lowest-priced material was sold as crude talc at prices ranging from $3.25 to $9.25 a ton, although the value of the latter was increased by grading according to quality, and averaged $10.50 per ton. Although prices of talc have advanced steadily since 1916, because of the high cost of labor and materials entering into the mining and milling of the product, it is interesting to note that the price of talc has advanced less than that of any of the other commodities entering into the manufacture of paper.

Talc imports in 1918 decreased, owing to the difficulties of ocean transportation. However, considerable activity was prevalent at Madoc, Ontario, and it is expected that final figures will show an increase of Canadian talc shipments to this country.

Few new developments are reported, although extensions of deposits now being worked have been disclosed. The Eastern Talc Co., at Rochester, Vt., is now developing a large body found by diamond drilling near the Williams mine.

The production of soapstone in New England declined in 1918, and in general, in the United States, the production of this material has been hampered by labor conditions and high freight rates. No actual figures are available on soapstone slabs, but the production of ground soapstone for 1918 was undoubtedly less than in 1917.

Depression in the Ukraine

The industrial conditions in the Ukraine seem to be going from bad to worse, says the *Ironmonger*. The iron industry is collapsing. All the 65 iron-smelting furnaces in the Ukraine, which formerly supplied 80% of the pig iron made in Russia, are idle. The coal output in the Donetz field is smaller than it has ever been, and the whole industrial life of the country is undermined. Trade restrictions and monopolies are encouraging speculation, and all business is handicapped by difficulties of transport. At a recent meeting of the Association of Trade and Agriculture held at Kieff, the Minister of Commerce declared that close relations with Russia were indispensable if industry in the Ukraine is to revive.

Mining Dividends

THE tables which follow show the dividends paid in 1917, 1918 and to date by the principal mining, metallurgical and holding companies of America that have paid dividends since 1913, except those which do not make public reports..

As most mines are commercial producers of two or more metals, no attempt is made to classify them as copper producers, lead producers, etc. Also, it is difficult to make a precise geographical distribution, and United States companies, such as the American Smelting and Refining, which have properties in two countries, are therefore, listed under United States for convenience.

Toward the end of 1917 many companies found it necessary to reduce or discontinue their payments, owing to war conditions and in 1918 the decrease continued, so that the total was $165,108,262, paid by 112 United States mining and metallurgical companies, compared with $245,337,018 in 1917.

Dividends paid by mining companies in Canada, Mexico, Central and South America also showed a decrease, as was to be expected, due to the same adverse conditions, and 1918 payments were $19,640,235, against $23,359,159 in 1917. Holding companies paid $1,983,732 in 1918 and $4,010,010 in the preceding year.

DIVIDENDS OF MINING AND METALLURGICAL COMPANIES IN THE UNITED STATES

Company Name	Situation	Shares Issued	Par Value	Dividends Paid 1917 Per Share	1917 Total	1918 Per Share	1918 Total	Total To Date	Latest Date	Latest Amount
Ahmeek, c	Mich.	200,000	$25	$16.00	$3,200,000	$10.00	$2,000,000	$11,250,000	Dec. '18	$2.00
Alaska Goldfields	Alas.	250,000	5	.10	25,000	.....	.....	428,250	Jan. '17	.10
Alaska Mexican, g	Alas.	180,000	5	.....	.....	.....	.....	3,507,381	Nov. '15	.10
Alaska Treadwell, g	Alas.	200,000	25	.....	.....	.....	.....	15,785,000	May '16	.50
Alaska United, g	Alas.	180,200	5	.....	.....	.....	.....	2,045,270	Feb. '16	.30
Allouez, c	Mich.	100,000	25	12.00	1,200,000	7.50	750,000	2,750,000	Dec. '18	1.50
Am. Mineral Prod	Wash.	1,500,000	1	.20	30,000	.10	15,000	60,000	Nov. '18	.10
Am. Sm. & Ref., com	U. S.-Mex.	609,980	100	7.00	4,269,860	6.00	3,659,880	40,975,758	Dec. '18	1.50
Am. Sm & Ref., pf	U. S.-Mex.	500,000	100	7.00	3,500,000	7.00	3,500,000	65,296,386	Dec. '18	1.75
Am. Smelters, pf. A	U. S.	98,675	100	6.00	699,572	6.00	586,435	12,969,542	Oct. '18	1.50
Am. Smelters, pf. B	U. S.	35,395	100	5.00	513,094	5.00	173,088	17,696,182	Oct. '18	1.25
Am. Zinc, Lead & Sm	U. S.	193,120	25	2.00	386,240	.....	.....	1,495,060	May '17	1.00
Am. Zinc, Lead & Sm., pfd	U. S.	96,560	25	6.00	483,238	6.00	483,238	1,223,125	Nov. '18	1.50
Anaconda, c	Mont.	2,331,250	50	8.50	19,815,625	8.00	18,650,000	146,357,500	Nov. '18	2.00
Argonaut, g	Calif.	200,000	5	.35	70,000	.20	40,000	1,890,000	Dec. '18	.05
Arizona Commercial, c	Ariz.	265,000	5	1.60	556,500	2.00	530,000	1,219,000	Oct. '18	.50
Arizona Copper, pf. (a)	Ariz.	.....	.....	.....	119,221	.....	119,221	2,486,728	Nov. '18	.....
Arizona Copper, com	Ariz.	1,519,896	1.20	1.14	1,754,339	.78	1,300,338	21,432,164	Aug. '18	.36
Arizona United, c	Ariz.	2,500,000	1	.03	75,000	.....	.....	100,000	July '17	.01
Atolia, tung	Calif.	100,000	1	13.00	1,300,000	7.00	700,000	5,654,500	Dec. '18	.50
Barnes-King, g	Mont.	400,000	5	.10	40,000	.40	160,000	260,000	Nov. '18	.10
Big Creek Leasing, l. s	Ida.	5,000	10	2.00	10,000	.....	.....	12,500	Dec. '17	.50
Big Four Explor	Utah	400,000	1	.....	.....	.....	.....	50,000	June '16	.05
Bingham Mines, c	Utah	150,000	10	1.25	187,500	2.50	375,000	562,500	Dec. '18	.50
Bingham-New Haven, (c)	Utah	228,690	5	.....	.....	.....	.....	960,494	Dec. '15	.20
Boss, g	Nev.	408,500	1	.08	32,680	.03	12,255	93,955	Feb. '18	.03
Brunswick, g	Calif.	395,287	1	.....	.....	.....	.....	203,315	Sept. '15	.06
Bunker Hill, Con., g	Calif.	200,000	1	.....	.....	.....	.....	931,000	Sept. '16	.02½
Bunker Hill & Sull., l. s	Ida.	327,000	10	6.25	2,043,750	4.75	1,553,250	22,086,750	Dec. '18	.50
Butte-Alex. Scott, c	Mont.	79,311	10	.....	.....	.....	.....	1,054,019(d)	Apr. '16	10.50
Butte-Bullwhacker, c	Mont.	1,000,000	1	.02½	25,000	.....	.....	25,000	Oct. '17	.01
Butte & Superior, z	Mont.	290,184	10	6.65	1,929,804	.....	.....	16,940,258	Sept. '17	1.25
Caledonia, l. s	Ida.	2,605,000	1	.36	937,800	.36	937,800	3,761,256	Dec. '18	.03
Calumet & Arizona, c	Ariz.	642,480	10	11.00	7,067,041	8.00	5,139,840	41,132,601	Dec. '18	2.00
Calumet & Hecla, c	Mich.	100,000	25	85.00	8,500,000	55.00	5,500,000	150,750,000	Dec. '18	15.00
Camp Bird, g.s	Colo.	1,100,051	4.86	.....	.....	.....	.....	9,185,498	Nov. '15	.24
Camp Bird, pfd	Colo.	649,625	4.86	.36	221,002	.18	110,501	1,607,888	July '18	.18
Cardiff, l. s	Utah	500,000	1	.25	125,000	.20	100,000	725,000	Oct. '18	.20
Centennial, c	Mich.	90,000	25	1.00	90,000	2.00	180,000	360,000	Dec. '18	1.00
Centennial-Eur., l.s.g.c	Utah	100,000	5	.....	.....	.....	.....	4,150,000	Apr. '16	1.00
Center Creek, l. s	Mo.	100,000	10	.35	35,000	.05	5,000	655,000	Apr. '18	.05
Cerro Gordo, z.l.s	Calif.	1,000,000	1	.22½	225,000	.05	50,000	299,375	Jan. '18	.05
Champion, c	Mich.	100,000	25	44.80	4,480,000	12.80	1,380,000	23,374,540	Aug. '18	6.40
Chief Con., s.g.l	Utah	884,228	1	.35	309,435	.45	397,901	1,234,871	Nov. '18	.12½
Chino, c	N. M.	869,980	5	9.90	8,612,802	4.50	3,914,910	26,403,042	Dec. '18	1.00
Coahuila, l.s	Mo.	300,000	1	.20	60,000	.....	.....	150,000	Nov. '17	.05
Colo. Gold Dredging	Colo.	100,000	10	.....	.....	.....	.....	775,000(e)	Feb. '16	1.00
Commercial	Ore.	1,641,000	1	.05	82,550	.....	.....	165,805	Nov. '17	.00½
Cons. Ariz. Smelting, c	Ariz.	1,663,000	5	.10	166,300	.20	332,600	498,900	Dec. '18	.05
Con. Interstate-Callahan, z	Ida.	298,303	10	2.00	929,980	1.25	688,717	6,966,082	Oct. '18	.75
Continental, z.l	Mo.	22,000	25	1.50	33,000	.50	11,000	638,000(f)	Jan. '18	.50
Copper Range, c	Mich.	395,000	25	10.90	3,943,912	6.00	2,366,394	25,420,704	Dec. '18	1.50
Cresson Cons., g	Colo.	1,220,000	1	1.20	1,464,000	1.20	1,464,000	7,271,162	Dec. '18	.10
Daly	Utah	150,000	20	.30	45,000	.40	60,000	3,030,000	Oct. '18	.10
Daly Judge, s.l. (g)	Utah	300,000	1	.....	.....	.....	.....	1,155,000	Dec. '15	.35
Davis Daly, c	Mont.	600,000	10	.....	.....	.75	450,000	450,000	Dec. '18	.25
Derry Ranch, g	Colo.	1,000	100	25.00	25,000	35.00	35,000	235,000	Oct. '18	7.50
Dr. Jack Pot, g	Colo.	2,843,342	.02½	.01	28,443	.....	.....	141,698	Jan. '17	.01
Dragon Con	Utah	1,875,000	1	.04	75,000	.04	75,000	150,000	Oct. '18	.01
Duluth & Utah Dev., l.s	Utah	50,000	.20	.....	.....	.....	.....	10,000	Mar. '15	.04
Dunkin, g	Colo.	200,000	1	.....	.....	.....	.....	55,000	Aug. '16	.07½
Eagle & Blue Bell, g.s.l	Utah	893,146	1	.40	357,258	.30	267,944	1,161,090	Sept. '18	.10
East Butte, c	Mont.	420,731	10	2.00	831,731	1.50	631,097	1,462,828	Dec. '18	1.50
Eastern Talc	Vt.	69,690	10	.....	41,220	.....	31,301	97,319	Sept. '18	.15
Electric Point, l	Wash.	793,750	1	.20	166,687	.06	47,625	214,312	Sept. '18	.03
Elko Prince, g.s	Nev.	1,108,566	1	.03½	38,800	.11½	127,484	166,284	Apr. '18	.05
Elkton Con., g	Colo.	2,500,000	1	.....	.....	.....	.....	3,579,465	May '15	.02
El Paso, g	Colo.	490,000	5	.....	.....	.....	.....	1,707,545	Feb. '14	.10
Empire Copper	Utah	1,000,000	1	.20	200,000	.05	50,000	830,000	Jan. '18	.05
Ernestine, g.s. (h)	N. M.	300,000	5	.....	.....	.....	.....	150,000	July '15	.10
Farncomb Hill Gold Dredg	Colo.	300,000	1.00	.16	48,000	.05	15,000	63,000	Oct. '18	.03
Federal M. & Sm., pf	Ida.	119,861	100	7.00	839,027	7.00	839,027	14,764,358	Dec. '18	1.75
First Nat. Cop	Calif.	600,000	5	.40	240,000	.....	.....	390,000	Aug. '17	.40
Fremont Con., g	Calif.	200,000	2.50	.....	.....	.....	.....	254,000	Oct. '14	.02
Gemini, g.s	Utah	5,000	100	5.00	25,000	.....	.....	2,455,000	Mar. '17	5.00
Golconda, g	Ariz.	850,000	1	.....	.....	.....	.....	170,000	Dec. '15	.10
Gold King, g	Colo.	1,000,000	1	.....	.....	.....	.....	1,417,319	Nov. '15	.01
Golden Cycle, g	Colo.	1,500,000	1	.36	520,000	.36	520,000	8,698,500	Dec. '18	.03
Goldfield Con., g	Nev.	3,559,148	10	.....	.....	.....	.....	28,999,832	Oct. '15	.10
Good Springs, Anchor, l.s	Nev.	550,000	1	.07	83,500	.....	.....	169,285	Aug. '17	.01
Grand Central, g	Utah	500,000	1	.16	80,000	.09	45,000	1,780,250	Oct. '18	.04
Grand Gulch	Utah	239,845	.10	.15	35,977	.....	.....	67,157	Dec. '17	.03

DIVIDENDS OF MINING AND METALLURGICAL COMPANIES IN THE UNITED STATES—Continued

Company Name	Situation	Shares Issued	Par Value	Dividends Paid 1917 Per Share	1917 Total	1918 Per Share	1918 Total	Total To Date	Latest Date	Latest Amount
Granite, g	Alas.	430,000	1					17,200	May '16	.02
Granite, g	Colo.	1,650,000	1	.03	49,500	.02	33,000	369,000	Mar. '18	.01
Hamburg, g.s.l	Nev.	1,000		.02	16,000			16,000	Apr. '17	.01
Hecla, l.s	Ida.	1,000,000	.25	1.60	1,600,000	.35	350,000	7,255,000	Dec. '18	.15
Homestake, g	S. D.	251,160	100	7.80	1,959,048	6.00	1,506,960	41,417,704	Dec. '18	.50
Horn Silver Min., s.c.z.l	Utah	400,000	45					5,682,000	July '16	.05
Horn Silver Mines (i)	Utah	400,000	1	.10	40,000	.05	20,000	80,000	Dec. '18	.05
Inspiration, c	Ariz.	1,181,967	20	8.25	9,751,228	8.00	9,455,736	25,391,081	Oct. '18	2.00
Inter'l Nickel, com	U. S.-Can.	1,673,384	25	5.75	9,621,958	4.00	6,693,536	52,276,984	Dec. '18	1.00
Intern'l Nickel, pf	U. S.-Can.	89,126	100	6.00	534,756	6.00	534,756	6,951,714	Nov. '18	1.50
Iowa, g.s.l	Colo.	1,666,667	1	.03	50,000	.02	33,333	370,166	Aug. '18	.00½
Iowa-Tiger, g.s.l	Colo.	3,000	1					25,179	Dec. '15	1.00
Iron Blossom, s.l.g	Utah	1,000,000	.10	.25	250,000	.07½	75,000	3,175,000	Oct. '18	.02½
Iron Cap, c	Ariz.	144,908	10		322,794		543,310	887,823	Dec. '18	.25
Iron Cap, pfd., c	Ariz.	(o)		.35	962			36,389	July '17	.35
Iron Silver, s.l.g	Colo.	500,000	20	.20	100,000			5,250,000	Dec. '17	.10
Isabella Mines, g.s	Colo.	2,528,331	1					742,500	Dec. '16	.01
Isle Royale, c	Mich.	150,000	25	6.00	900,000	1.50	375,000	1,875,000	Dec. '18	.50
Jamison, g	Calif.	390,000	10					386,100	Dec. '15	.01
Jerry Johnson, g	Colo.	2,500,000	.10					187,500	Nov. '14	.00½
Jim Butler Tonopah, g.s	Nev.	1,718,021	1	.20	343,604	.17	292,063	1,151,074	Aug. '18	.07
Joplin Ore & Spelter	Mo.	2,000,000	1					63,000	July '16	.40½
Judge Min. & Sm.(m)	Utah	480,000	1	1.00	480,000	.37½	180,000	2,250,000	Oct. '18	.12½
Jumbo Ext., g.s	Nev.	1,550,000	1					687,158	June '16	.05
Kendall, g	Mont.	500,000	5					(f) 1,555,000	Apr. '16	.10
Kennecott Copper, c		2,786,953		5.70	15,885,643	4.00	11,151,071	42,356,997	Dec. '18	1.00
Kennecott Mines, c	Alas.	250,000	10	(k)				5,000,000	Jan. '14	4.00
Knob Hill, g	Wash.	993,834	1	.01½	13,907			99,815	July '17	.00½
Lake View, z	Utah	500,000	1					125,000	June '16	.01
Liberty Bell, g	Colo.	133,560	5	.15	200,327	.30	400,668	2,594,181	Sept. '18	.05
Linden, z	Wis.	1,020	10					11,220	Dec. '15	3.00
Little Bell, l.s	Utah	300,000	1					90,000	Apr. '16	.05
Loon Lake, c	Wash.	1,461,685	.25	.03	43,352			43,352	Sept. '17	.01
Lower Mammoth, g.s.c	Utah	1,000,000	1					67,000	Dec. '15	.01
Magma, c	Ariz.	240,000	5	2.10	504,000	1.50	360,000	1,584,000	Sept. '18	.50
Mammoth, g.s.c	Utah	400,000	.10	1.00	400,000			2,820,000	Nov. '17	.10
Mary McKinney, g	Colo.	1,309,252	1					1,182,398	Oct. '16	.01
Mary Murphy, g	Colo.	370,000	5					93,106	May '16	.07
Mass Con., c	Mich.	97,317	25	3.00	291,951			486,585	Nov. '17	1.00
May Day, g.s.l	Utah	800,000	.25					300,000	Dec. '16	.02
Mexican, s	Nev.	201,600	1					171,360	Nov. '14	.75
Miami, c	Ariz.	747,114	5	8.75	6,537,247	4.50	3,362,013	19,595,044	Nov. '18	1.00
Mogollon Mines, g.s	N. M.	355,682	5					53,352	Oct. '15	.05
Mohawk, c	Mich.	100,000	25	20.50	2,050,000	10.00	1,000,000	8,625,000	Nov. '18	2.00
Moscow M. & M., g.s.c.z	Utah	900,000	1	.04½	40,500			108,000	Aug. '17	.02
Mountain King	Calif.	598,340	1					17,950	Apr. '16	.03
National Zinc and Lead, l.z	Mo.	500,000	1	.04	20,000			210,000	May '17	.02
Nevada Con., c	Nev.	1,999,457	5	4.15	8,297,747	3.25	6,498,236	42,269,839	Dec. '18	1.00
Nevada Packard, g	Nev.	1,164,492	1			.02½	29,700	87,000	Sept. '18	.02½
Nevada Wonder, g.s	Nev.	1,408,240	1	.20	281,680	.20	281,694	1,478,582	Nov. '18	.10
New Cornelia, c	Ariz.	1,404,900				.25	351,225	351,225	Nov. '18	.25
New Idria, q	Calif.	100,000	5	3.00	300,000	1.50	150,000	2,680,000	Oct. '18	.50
New Jersey Zinc	U. S.	350,000	100	46.00	16,100,000	20.00	7,000,000	(s)	Nov. '18	4.00
North Butte, c	Mont.	430,000	15	2.50	1,075,000	1.00	430,000	14,657,000	Oct. '18	.25
North Star, g	Calif.	250,000	10	1.00	250,000	.40	100,000	5,437,040	June '18	.40
Oaks Co., pfd	N. M.	1,690	10	.37½	465			634	Apr. '17	.17½
Old Dominion Co., c	Ariz.	297,071	25	8.00	2,376,262			13,216,976(q)	Dec. '17	1.00
Old Dominion M. & Sm., c (p)	Ariz.	162,000	25					8,424,000	Dec. '16	3.50
Ontario Silver Min	Utah	150,000				1.00	150,000	(s)	Oct. '18	.50
Optimo, g	Wis.	545	100					43,960	Sept. '15	10.00
Oroville Dredging, g	Calif.	686,538	4.86	.48	329,540	.36	247,155	2,683,920	Sept. '18	.12
Osceola, c	Mich.	96,150	25	20.00	1,923,000	8.00	769,200	17,179,475	Sept. '18	2.00
Pacific Gold	Utah	400,000	.10			.02	8,000	16,000	Apr. '18	.01
Pacific Mines	Calif.	642,000	1					276,060	Dec. '16	.01
Parrot, c	Mont.	229,850	10					7,871,839	July '15	1.63
Phelps Dodge	U. S.	450,000	100	32.00	14,400,000	22.00	9,900,000	84,596,000	Sept. '18	8.00
Pittsburgh-Idaho, l	Ida.	817,692	1	.08	65,524			363,359	Apr. '17	.03
Pittsburg-Silver Peak, g	Nev.	2,790,000	1					771,200	July '14	.02
Plymouth, g	Calif.	240,000	4.86	.48	117,040	.48	117,040	579,680	July '18	.24
Portland, g	Colo.	3,000,000	1	.12	360,000	.10	300,000	11,257,080	Oct. '18	.02
Prince Con., l.s	Utah	1,000,000	2	.20	200,000			575,000	Nov. '17	.02½
Quincy	Mich.	110,000	25	18.00	1,980,000	8.50	935,000	26,452,500	Dec. '18	2.00
Ray Con., c	Ariz.	1,577,179	10	4.20	6,624,152	3.25	5,124,331	20,679,583	Dec. '18	.75
Reorg. Booth, g	Nev.	1,000,000	1					500,000	July '16	.10
Rescue Eula, g.s	Nev.	1,478,910	1	.02½	35,539			35,539	June '17	.02½
Rico-Wellington, l.z.c	Colo.	1,000,000	.10		39,600			39,600	July '17	
Richmond	Ida.	840,000	1	.10	84,000	.01	8,400	92,400	Oct. '18	.01
Rochester, g	Nev.	2,000,000				.04	80,000	80,000	Oct. '18	.02
St. Joseph, l	Mo.	1,409,466	10	3.50	4,933,124	2.00	2,818,932	21,543,616	Dec. '18	.50
Seven Tr. Coalition, g	Nev.	1,443,077	1					252,572	Apr. '16	.02½
Shannon, c	Ariz.	300,000	10	1.25	525,000			1,425,000	Nov. '17	.25
Shattuck Arizona, c	Ariz.	350,000	10	5.00	1,750,000	2.00	700,000	7,087,500	Oct. '18	.50
Silver King Coalition, l.s	Utah	1,250,000	5	.60	729,660	.15	182,415	15,198,560	Jan. '18	.15
Silver King Con., l.s	Utah	827,237	1	.55	383,287	.10	70,000	1,562,705	Apr. '18	.10
Skidoo, g	Calif.	1,000,000	5					365,000	Oct. '14	.01
Socorro, g	N. M.	377,342	5					252,666	Oct. '16	.05
South Hecla	Ida.	263,000	1					39,438	Aug. '16	.15
Stewart, s.l	Ida.	1,238,262	1					2,012,314	Dec. '15	.05
Stratton's Ind., g	Colo.	1,000,000	.30					(s)	Jan. '16	.16
Success, z	Ida.	1,500,000	1					1,125,000	July '16	.03
Superior & Pitts, c	Ariz.	1,499,792	10					10,318,569	Dec. '15	.38
Superior, c	Mich.	100,000	25	1.00	100,000			200,000	Apr. '17	1.00
Tamarack & Custer	Ida.	1,776,288	1	.06	124,340	.12	266,439	461,830	Aug. '18	.06
Tennessee, c	Tenn.	200,000	25					5,206,250	Apr. '16	.75
Tennessee Cop. & Chem	Tenn.	392,817				1.00	392,817	392,817	May '18	1.00
Tightner, g	Calif.	100	1,000					160,000	Jan. '14	500.00
Tintic Standard,, l.s	Utah	1,167,500	.01	.07	81,725	.17	198,475	280,200	Sept. '18	.08
Tom Reed, g	Ariz.	909,555	1			.04	36,382	2,565,030	Dec. '18	.02
Tomboy, g.s	Colo.	310,000	4.86	.48	150,660	.12	37,665	4,126,140	June '18	.12
Tonopah-Belmont, s.g	Nev.	1,500,000	1	.50	750,016	.35	525,009	9,668,063	July '18	.10
Tonopah Ext., g.s	Nev.	1,282,801	1	.25	320,700	.05	64,140	1,976,560	Sept. '18	.05
Tonopah Mining, g.s	Nev.	1,000,000	1	.55	550,000	.37½	375,000	14,525,000	Oct. '18	.15
Trimountain, c	Mich.	100,000	25			5.00	500,000	1,950,000	May '18	5.00
Union Con., s	Nev.	200,000	1			.20	40,000	40,000	July '18	.05
United (Crip Ck.) g	Colo.	4,000,000		.01	40,000			520,385	Dec. '17	.01
United Copper	Wash.	1,000,000	1	.10	100,000			150,000	Oct. '17	.01
United Eastern, g	Ariz.	1,363,000	1	.30	408,900	.62	845,060	1,253,960	Dec. '18	.07
United Globe, c	Ariz.	23,000	100					4,255,000	Dec. '16	22.00
U. S. Sm., Ref. & Min	U. S.-Mex.	351,115	50	5.00	1,755,575	5.00	1,755,575	10,365,733	Oct. '18	1.25

DIVIDENDS OF MINING AND METALLURGICAL COMPANIES IN THE UNITED STATES—Continued

Company Name	Situation	Shares Issued	Par Value	Dividends Paid 1917 Per Share	1917 Total	1918 Per Share	1918 Total	Total To Date	Latest Date	Latest Amount
U. S. Sm., Ref. & Min., pfd	U. S.-Mex.	486,350	50	3.50	1,702,225	3.50	1,702,225	21,476,812	Oct. '18	.87½
United Verde, c	Ariz.	300,000	10	17.25	5,175,000	18.50	5,550,000	(s)	July '18	1.50
United Verde Ext., c	Ariz.	1,050,000	.50	2.85	2,992,500	4.50	3,675,000	6,667,500	Nov. '18	.75
Utah Apex, c	Utah	528,200	5	.75	396,150	.50	464,100	1,122,425	Nov. '18	.25
Utah Con., c	Utah	300,000	5	3.50	1,050,000	1.25	375,000	11,700,000	Sept. '18	.25
Utah Copper, c	Utah	1,624,490	10	14.50	23,555,105	8.50	13,808,165	89,579,047	Dec. '18	2.00
Utah Leasing	Utah	250,000	.10	.15	47,500	.09	22,500	95,000	Nov. '18	.02
Utah Metal & Tunnel	Utah	691,588	1	.80	553,262	.....	.....	895,734	Dec. '17	.30
Vindicator Con., g	Colo.	1,500,000	1	.12	180,000	.04	60,000	3,772,500	Oct. '18	.01
Warrior Copper, pfd	Ariz.	68,000	10	.70	47,600	.....	.....	47,600	Dec. '17	.70
Wasp No. 2, g	S. D.	500,000	1	.03	15,000	.....	.....	664,466	Apr. '17	.03
Wellington, g	Colo.	1,000,000	1	.40	400,000	.20	200,000	1,850,000	May '18	.10
West End Con., s	Nev.	1,788,486	1	.05	89,424	.20	357,698	1,073,092	Oct. '18	.10
Western Development, pfd	Colo.	50,000	10	.....	.....	2.00	100,000	100,000	Dec. '18	.50
Western Utah, c	Utah	2,496,500	1	.....	.....	.07½	18,724	18,724	Feb. '18	.07½
White Pine, pfd., c	Mich.	24,000	25	.....	126,051	.....	.....	126,051	Apr. '17	.....
Wilbert, l.s	Utah	1,000,000	1	.05	50,000	.....	.....	100,000	Nov. '17	.01
Wolverine & Ariz., c	Ariz.	118,575	15	.....	.....	.25	29,668	83,072	July '18	.25
Wolverine, c	Mich.	60,000	25	13.50	810,000	4.00	240,000	10,170,000	Oct. '18	1.00
Yak, s.l	Colo.	1,000,000	1	.71	710,000	.....	.....	3,477,685	Sept. '17	.07
Yellow Aster, g	Calif.	1,079,750	1	.35	35,000	.....	.....	1,245,789	July '17	.05
Yellow Pine, z.l.s	Nev.	1,000,000	1	.36	360,000	.30	300,000	2,370,000	Dec. '18	.12
Yosemite, g	Calif.	24,000	10	.....	.....	.....	.....	125,893	Dec. '14	.02
Yukon Gold, g	Alas.	3,500,000	5	.30	1,050,000	.05	175,000	9,858,110	June '18	.02½
Totals	.....	.....	.....	.....	$245,337,018	.....	$165,108,262	$1,569,478,434	.....	.....

CANADIAN, MEXICAN, SOUTH AND CENTRAL AMERICAN MINING COMPANIES

Aladdin Cobalt	Ont.	500,000	$4.86	$0.096	$48,000	.....	.....	$48,000	Feb. '17	$0.096
Amparo, g.s	Mex.	2,000,000	1	.16	320,000	.15	300,000	2,952,176	Nov. '18	.04
Asbestos Corpn	Que.	30,000	100	4.00	160,000	.....	.....	160,000	Nov. '18	1.25
Beaver Con., s	Ont.	2,000,000	1	.....	.....	.....	.....	649,912	Apr. '16	.03
Blanca y Anexas, s	Mex.	140,000	10	.....	.....	.....	.....	1,943,000	Mar. '14	.90
Buena Tierra, s.l	Mex.	330,000	4.86	.....	.....	.....	.....	160,380	Feb. '15	.24
Buffalo, s	Ont.	1,000,000	1	.....	.....	.....	.....	2,787,000	July '14	.05
Butters' Salvador, g	C. A.	150,000	4.86	.....	.....	.....	.....	4,138,050	Oct. '16	.24
Canadian Goldfields, g.s	Can.	600,000	.10	.....	.....	.....	.....	290,000	July '14	.01½
Caribou Cobalt, s	Ont.	1,000,000	1	.05	50,000	.....	.....	175,000	Apr. '17	.05
Casey Cobalt, s	Ont.	249,950	4.86	.....	.....	.....	.....	148,807	May '14	.12
Cerro de Pasco, c	Peru	898,224	..	5.75	4,009,470	5.00	4,393,353	11,069,487	Dec. '18	1.25
Chontalpan, g.s.l.z	Mex.	7,000	25	.....	.....	.....	.....	57,750	Apr. '14	.75
Coniagas, s	Ont.	800,000	5	.62½	500,000	.62½	500,000	9,440,000	Nov. '18	.25
Con. M. & S. of Can	B. C.	419,098	25	2.50	995,012	2.50	1,047,744	4,994,105	Oct. '18	.62½
Crown Reserve, s	Ont.	1,768,814	1	.05	88,440	.....	.....	6,190,849	Jan. '17	.05
Dome Mines, s	Ont.	400,000	10	.75	300,000	.....	.....	1,500,000	June '17	.25
Encinas y Anexas	Mex.	3,000	10	.....	.....	.....	.....	30,105	Mar. '14	3.03½
El Favor, g	Mex.	3,500,000	1	.....	.....	.....	.....	210,000	Apr. '14	.01
El Oro, g.s	Mex.	1,147,500	4.86	.24	57,375	.....	.....	8,725,793	Oct. '17	.24
El Rayo, g.s	Mex.	260,020	2	.....	.....	.....	.....	967,223	Dec. '15	.10
Esperanza, s.g	Mex.	455,000	4.86	.24	109,200	.48	218,400	12,435,798	Aug. '18	.24
Granby, s.l.c	B. C.	150,004	100	10.00	1,500,042	10.00	1,500,042	9,776,885	Nov. '18	2.50
Greene Cananea, c	Mex.	500,000	100	8.00	3,954,215	8.00	4,000,000	15,747,165	Nov. '18	2.00
Greene Con., (n)	Mex.	1,000,000	10	2.00	2,000,000	.....	.....	15,544,400	Apr. '17	1.00
Hedley Gold	B. C.	240,000	10	2.00	240,000	.75	144,000	2,447,520	Dec. '18	.15
Hollinger, g	Ont.	4,920,000	5	.15	738,000	.25	1,230,000	9,424,000	Dec. '18	.05
Howe Sound, c	B. C.	1,984,150	1	.....	.....	.15	297,624	297,624	Oct. '18	.05
Kerr Lake, s	Ont.	600,000	5	1.15	690,000	1.00	600,000	8,010,000	Dec. '18	.25
Lake Shore, s	Ont.	2,000,000	1	.....	.....	.05	100,000	100,000	Dec. '18	.02½
La Rose Mines, s (r)	Ont	1,500,000	1	.20	320,000	.02	30,000	7,505,410	Apr. '18	.02
Le Roi No. 2, g	B. C.	120,000	24.25	.24	29,160	.....	.....	2,075,103	Mar. '17	.24
Lucky Tiger-Com., g	Mex.	715,337	10	.59	422,049	.50	357,668	4,558,151	July '18	.05
McIntyre Porcupine, s	Ont.	3,610,283	1	.15	541,542	.10	361,028	1,083,084	Nov. '18	.05
McK.-Dar. Sav., s	Ont.	2,247,692	1	.12	269,724	.12	269,724	5,415,947	Oct. '18	.03
Mexico Mines of El Oro, g.s	Mex.	180,000	4.86	5.28	934,700	3.36	612,360	5,166,143	Sept. '18	1.44
Min. Corp. of Can., s	Ont.	1,600,050	5	.93¾	1,556,297	.81¼	1,333,792	4,238,839	Dec. '18	.18¾
N. Y. & Hond. Ros., s.g	C. A	200,000	10	2.00	400,000	2.00	400,000	4,990,000	Oct. '18	.50
Nipissing, s	Ont.	1,200,000	5	1.50	1,800,000	1.25	1,500,000	18,240,000	Oct. '18	.25
No. Am. Magnesite	Que.	1,866	100	10.00	18,660	.....	.....	69,042	Oct. '17	5.00
Peterson Lake, s	Ont.	2,401,820	1	.01¾	42,032	.....	.....	504,382	Jan. '17	.01¾
Porcupine-Crown, g	Ont.	2,000,000	1	.09	180,000	.....	.....	840,000	July '17	.03
Rambler-Cariboo, c	B. C.	1,750,000	1	.02	35,000	.....	.....	432,500	Sept. '17	.01
Right of Way Mines, s	Ont.	1,685,500	1	.02½	8,428	.....	.....	577,469	Mar. '17	.00½
San Rafael, g.s	Mex.	2,400	25	.....	.....	.....	.....	1,442,380	Jan. '14	.50
Santa Gertrudis, g.s	Mex	1,500,000	4.86	.18	273,375	.24	364,500	3,454,272	June '18	.24
Seneca-Superior, s	Ont.	478,884	1	.....	.....	.....	.....	1,579,817	Dec. '16	.05
Standard s.l	B. C.	2,000,000	1	.15	300,000	.....	.....	2,700,000	Oct. '17	.05
Temiskaming, s	Ont.	2,500,000	1	.12	300,000	.03	75,000	2,059,156	Jan. '18	.03
Tem. & Hud. Bay, s	Ont.	7,761	1	.....	.....	.....	.....	1,940,250	Nov. '14	3.00
Tough-Oakes, g	Ont.	531,500	5	.12½	66,438	.....	.....	398,625	Jan. '17	.12½
Townsite Extension, s	Ont.	150,000	4.86	.12	18,000	.....	.....	18,000	Oct. '17	.12
Tretheway, s	Ont.	1,000,000	1	.05	50,000	.....	.....	1,161,998	Aug. '17	.05
Utica Mines, l	B. C.	1,600,000	1	.04	64,000	.....	.....	64,000	Sept. '17	.02
Totals	.....	.....	.....	.....	$23,359,159	.....	$19,640,235	$199,105,597	.....	.....

HOLDING COMPANIES

Amalgamated, c	Mont.	1,538,879	$100	.....	.....	.....	.....	$103,444,983	Aug. '15	$3.71
California Expl	.....	231,617	2.40	$0.24	$56,278	.....	.....	140,695	Oct. '17	.12
General Development	U. S.	120,000	25	7.00	840,000	2.75	330,000	4,853,917	Sept. '18	.75
Guggenheim Expl	U. S.	833,732	25	.....	.....	.....	.....	34,036,783(l)	Apr. '16	11.85
Old Dominion (holding) (q)	Ariz.	293,353	25	(q)	(q)	(q)	(q)	(q)	Dec. '16	3.50
St. Mary's Min. Land	Mich.	160,000	25	14.00	2,240,000	5.00	800,000	11,360,000	Nov. '18	1.00
White Knob C. & D., pf	.....	200,000	10	.30	60,000	.20	40,000	310,000	Nov. '18	.05
Yukon-Alaska Trust	.....	203,433	...	4.00	813,732	4.00	813,732	2,237,763	Dec. '18	1.00
Totals	.....	.....	.....	.....	$4,010,010	.....	$1,983,732	$156,384,141	.....	.....

(a) Two classes. (c) Taken over by Utah Metal and Tunnel Co. (d) Liquidation dividend of $10.50 per share in 1916 is included. (e) Includes return of capital; property sold to Tonopah Placers Co. (f) Includes liquidation payment. (g) Reorganized as Judge Mining and Smelting Co. (h) Absorbed by Mogollon Mines Co. in 1915. (i) Reorganization of Horn Silver Mining Co. (k) Reorganized as Kennecott Copper Corporation. (l) Liquidation payment of $11.85 per share in 1916 is included. (m) Successor of Daly-Judge Mining Co. (n) Taken over in 1917 by Greene Cananea. (o) Called for redemption Nov. 15, 1917. (p) Dissolved in Mar., 1917; succeeded by Old Dominion Co. (q) Old Dominion Co. (holding) is included in the list of operating companies beginning 1917, as it has absorbed the Old Dominion Copper Mining and Smelting Co. "Total dividends to date" include payments by the Old Dominion Co., before the absorption. (r) La Rose Consolidated was dissolved in 1918; assets transferred to La Rose Mines, Ltd. (s) Not reported.

Pyrites, Sulphur, and Sulphuric Acid

IN A REPORT to the Committee on Mines and Mining of the U. S. Senate on May 10, 1918, W. R. Ingalls made the following statement respecting pyrites, sulphur, and sulphuric acid:

An increased requirement for sulphuric acid and a necessary reduction in the importation of pyrites from Spain have created a deficiency in the supply of this important material, but the tension in the situation is probably overestimated, and natural factors are applying the true correctives.

In Louisiana and Texas we possess the greatest deposits of sulphur (brimstone) in the world, exploitation of which has heretofore been limited more by inability to market the product than anything else. Without any doubt, the supply can be increased immensely. The matter of sulphuric acid is perhaps the most complex of these problems. The United States possesses ample sources of sulphur, but the great resources are remote from the places where the sulphur is mainly needed, and both utilization and transportation difficulties stand in the way. Spanish pyrites comes cheaply to places where there are acid works and local channels of acid consumption. The utilization of the enormous quantity of sulphurous gas that is dispersed daily into the atmosphere at Anaconda, Mont., for example, would necessitate a stupendous outlay for manufacturing plant, for tank cars, and for transportation.

The production of sulphuric acid in terms of monohydrate (H_2SO_4) in 1917 was about 4,300,000 tons, against about 3,900,000 in 1916. The Government estimates a requirement of 5,000,000 to 5,600,000 tons. We imported from Spain about 833,000 short tons of pyrites in 1917, which may be reckoned as making about 1,000,000 tons of sulphuric acid (monohydrate). If, therefore, we are to require as much acid as the Government's maximum estimate, stupendous though it be, and if we were not to import any pyrites from Spain, we should have to find raw material for about 2,300,000 tons of acid. Although that is a very large figure, the situation as to brimstone is of such a nature as to dispel any alarm. Moreover, importations of pyrites will not be checked entirely; for the domestic production of pyrites is increasing, and smelters are adding to their production of acid as a byproduct, wherefore it need not be assumed that new sources for 2,300,000 tons of acid must be found.

In 1915-16, sulphuric acid of 60° B., which in pre-war times realized about $6 to $8 per ton, sold at $50 and $60 per ton. Before the end of 1916 the price had receded practically to the pre-war normal. Referring to this subject, the *Engineering and Mining Journal* remarked, Nov. 18, 1916, that:

"One of the war commodities that has come down to earth again is sulphuric acid. In the acute period this fetched $50 and $60 per ton. Ordinarily tower acid is now down to about $7 and $8 per ton, which is only a trifle in excess of what it used to be in normal times. The explanation is increased production. The consumption is still very large."

The price of $7 and $8 per ton at that time was undoubtedly subnormal, considering increased cost of production. At the beginning of 1917 the market was $12 and $13, and even that was regarded as low. It advanced during 1917 and was quoted at $22 and $25 at the close of the year. The recent price in the open market has been about $25, but the War Industries Board has arranged for Government requirements at $18.

The subsequent events of 1918 verified the above statements and opinions. During July the War Industries Board issued the statement that there was above ground, and had been all along, at the mines in Louisiana and Texas, over 1,000,000 tons of brimstone. According to W. G. Woolfolk, the consumption of brimstone at the middle of 1918 was approximately 120,000 tons a month; wherefore the existing stock was sufficient for eight months, even if production should be suspended entirely, which was scarcely conceivable. Mr. Woolfolk was, therefore, of the opinion that there had been no occasion for alarm over the alleged small supply of sulphur in this country.

In October, the War Industries Board issued a statement that the situation as to supply of sulphuric acid was easy, and citizens were warned against making further investments in pyrites mining. Later (in December) a report on the present sulphuric-acid capacity of plants in the United States and on the requirements for 1919 was made to the Chemical Alliance by Arthur E. Wells, who is one of the sulphuric-acid specialists of the War Industries Board. This report was as follows:

On Jan. 1, 1918, the total manufacturing capacity of the country for acid was 5,124,000 tons (basis 100% H_2SO_4), or 8,200,000 tons per year (basis 50° B.), of which 29% was at contact acid plants.

On Nov. 1, 1918, the total manufacturing capacity of the country was at the rate of 6,000,000 tons per year (basis 100% H_2SO_4), or 9,600,000 tons (basis 50° B.). Of this total capacity 40% was at contact acid plants.

This capacity was divided among (1) Government, (2) explosives companies, (3) all others, including commercial manufacturers and byproduct manufacturers, as follows, in tons:

	100% H_2SO_4	50° B.
(1) At Government plants	648,000	1,040,000
(2) At plants of explosives manufacturers	696,000	1,120,000
(3) All others	4,656,000	7,440,000
Totals	6,000,000	9,600,000

The total capacity east of the Mississippi River, and also including the plant at Argentine, Kan., and the plants in Louisiana and Arkansas, is 5,448,000 tons per month as 100% H_2SO_4. The report continues:

If it be assumed that the Government plants and the contact plants, which were built by the explosives companies primarily to supply acid for munitions explosives, are not operated in 1919, or, if operated at all, that the production will be utilized only for munitions, and thus will not be placed on the market, there remains a total capacity to be considered in the eastern part of the United States amounting to 4,380,000 tons (basis 100% H_2SO_4), or 7,000,000 tons per year (basis 50° B.).

During the first nine months of 1918 the actual rate of production was only about 90% of the rated maximum capacity, although many plants were operating much above the rate capacities. Therefore, it is fair to conclude that the probable maximum output from these plants for 1919 cannot be greater than 90% of the rated capacity, or, in other words, the maximum output could be only about 328,000 tons (basis 100% H_2SO_4), or 525,000 tons per month (basis 50° B.).

Not only was the requirement for sulphuric acid overestimated, and the supply *in esse* and *in posse* at all times ample, but also the Texas Gulf Sulphur Co. was pushing the completion of its plant for the exploitation of a large deposit of brimstone in Texas, from which it will be ready to produce early in 1919, and the question is now how to find a market for the prospective production of brimstone. The outlook is that this can be done only at the expense of pyrites, which, of course, means the sale of brimstone at a much lower price than heretofore, but the cost of production will permit that to be done.

On June 27, 1918, the War Industries Board fixed a maximum price of $18 per ton for 60° B. acid and $28 for 66° B., f.o.b. sellers' works. These prices were changed on Sept. 30 to $16 for 60° B. and $25 for 66° B.

Although the acid production in this country has increased largely during the last four years, manufacturers do not anticipate that any great difficulties will be experienced in readjusting themselves to new conditions. Many of those who under normal conditions produced acid as a byproduct, such as the Eastern zinc and copper smelters, found it desirable, in view of the enormous demand, to increase their output considerably by the use of brimstone. All such brimstone acid making can readily be discontinued. There were also numerous plants operated by the Government direct, and these too will undoubtedly be discontinued. It is not unlikely that many of the smaller producers who

were attracted by the possibilities of the acid business for explosives, etc., during 1918, and who were able to operate successfully under the prevailing prices, will find themselves compelled gradually to curtail their production. In view of these factors, therefore, all of which operate toward a reduced production, and because of the further important fact that numerous uses for sulphuric acid, which bid fair to become increasingly important as time goes on, have grown up out of the war, there is a feeling that the acid market will soon adjust itself to a stable position.

Magnesite Industry in 1918

Changing market conditions and the unusual difficulties of transportation in 1918 brought about the closing of most of the smaller companies producing magnesite at the beginning of the year. This and a decrease in output of almost a third from that of 1917, together with the outdistancing of California, as a producer, by Washington, were the dominant features.

The production of magnesite in the United States during the first nine months of 1918 is given by R. W. Stone, of the U. S. Geological Survey, as 160,000 tons, of which 90,500 tons came from Washington and the rest from California. The total for the year is estimated at 225,000 tons, against 316,000 in 1917. Of the total in 1918 the Northwest Magnesite Co., operating at Chewelah, Wash., produced about 100,000 tons of crude magnesite, from which it made approximately 40,000 tons of dead-burned magnesite.

Washington produced its first magnesite in December, 1916, when less than a thousand tons was shipped. In 1917, the state yielded about 100,000 tons, which figure was exceeded in 1918. The utilization of dead-burned dolomite as a refractory, the freight embargo east of Chicago in the early part of the year, car shortage, and increased freight rates curtailed the 1918 production in both states, but California suffered more than Washington for two reasons: First, Washington crystalline magnesite has been found to make the better refractory, and, second, restrictions on building lessened the demand for the California mineral, which is lighter in color than the Washington magnesite and better suited for building purposes. Also, dolomite displaced California magnesite to some extent in the sulphite process for making wood-pulp.

Crude magnesite sold for $7 to $10 per ton during 1918, the demand being almost entirely local by calcining plants situated near deposits. Caustic and non-ferrous calcines sold for $32.50 to $40 per short ton, depending on quantity and length of contracts. Washington magnesite averaged about $37.50, with higher prices for ferromagnesite. Pacific Coast production of ferromagnesite was not large. Almost all calcined sold by local producers was shipped East and recalcined with addition of iron. Specifications for crude magnesite required that it should not exceed 3% SiO_2 and 2% lime; calcined not over 5 or 6% SiO_2 and 3 or 4% lime; caustic not over 6% CO_2; and dead burned not over 0.5% CO_2.

Imports of magnesite in the United States during the first eleven months of 1918, according to the Department of Foreign and Domestic Commerce, were: England, two tons; Scotland, 728; Canada 17,351; and Mexico, 1082; total, 19,163.

The importation of magnesite except by rail was prohibited by the War Shipping Control Board in its general embargo list issued in June, thus cutting off small shipments that were coming in from the Mediterranean, and preventing resumption of shipments from the island of Margarita, Venezuela. The War Trade Board in July amended this restriction so as to permit the mineral to be brought in as return cargo from Mediterranean ports and from ports where loading could be done without delay. Magnesite was one of the minerals covered in the War-Minerals Bill. It was removed from the Export Conservation List by order of the War Trade Board, effective Dec. 6.

In Margarita, the only two companies operating, the American Magnesite Co. and the Magnesite Products Corporation, both of New York, were closed through political influences. This threw 300 men out of work and injured American interests. About 3,200,000 tons of magnesite is estimated by C. F. Z. Caracristi to be available there. The most important property on the island, known as Estacia, was recently purchased by a New York company.

In Canada in 1918, as in previous years, production of magnesite was confined to the so-called Grenville district of Quebec, midway between Ottawa and Montreal and including the townships of Grenville and Harrington. This magnesite contains 5 to 10% of lime, the dead-burned material containing 15% of lime. The crude mineral was shipped throughout 1918 to cement works in Montreal and in Hull, near Ottawa, where it was ground and burned in the large rotary kilns, which otherwise would have lain unused, owing to the decreased activities in building. The average production of dead-burned magnesite from all works was about 150 tons a day throughout 1918.

Though there are large deposits of hydromagnesite of exceptional purity in British Columbia, remotely situated in the Atlin and Kamloops districts, there has been no production to date.

Producing companies in the United States in 1918 numbered 19 in California and 2 in Washington. The close of the year saw but 6 of California's 19 still in operation. The following list of 1918 producers has been furnished by the U. S. Geological Survey:

California: Clark & McDonald, Livermore, producers of crude; J. H. Plattner, Livermore, crude; Piedra Magnesite Co., Fresno, crude; Sinclair Bros. & Ferguson, Piedra, calcined; George W. Elder, St. Helena, crude; Bay Cities Water Co., Coyote, crude (owns property operated by lessees); Western Magnesite Development Co., 519 California St., San Francisco, crude and calcined; F. Albertz, Cloverdale, crude; Gustine Magnesite Co., Ingomar, crude; Red Mountain Magnesite Co., Marine Bldg., San Francisco, crude and calcined; Standard Magnesite Co. of California, 244 California St., San Francisco, crude; E. Duryee, 1205 Hollingsworth Bldg., Los Angeles, crude; H. T. Haden, Dinuba, crude. The following are believed to have been operating at the close of 1918: Frank R. Sweasy (White Rock mine), Humboldt Bank Bldg., San Francisco, crude and calcined; Wellman-Lewis Co., 901 Hibernian Bldg., Los Angeles, crude and calcined; Sonoma Magnesite Co., Humboldt Bank Bldg., San Francisco, crude and calcined; Tulare Mining Co., 310 Sansome St., San Francisco, crude and calcined; and Porterville Magnesite Co. of California, Porterville, crude and calcined.

Washington: American Mineral Production Co., 622 Insurance Exchange Bldg., Chicago, Ill., crude and calcined, operating; and Northwest Magnesite Co., Hutton Bldg., Spokane, crude and calcined, operating.

The Northwest Magnesite Co., by far the largest producer, and with a million-dollar plant erected since the war began, stated on Aug. 30 that it required 291 employees to operate.

The Southeastern Missouri Lead District

By H. A. WHEELER*

THE Southeastern lead district of Missouri produced about 168,000 tons of pig lead in 1918, of an approximate value of $25,000,000. This is the first year that the district has failed to show a substantial increase in its annual output in a period of steady growth extending over 50 years. The lead tonnage for 1918 is about 15% less than that of 1917, the latter year marking the crest in tonnage and value, 198,000 tons having been produced, of a value of about $35,000,000. The unusually high value of the 1917 output was due to the phenomenal conditions created by the war, when for a short period lead reached the unheard of price of 12c. per lb., which naturally stimulated a peak production.

The lead market in 1918 ranged from 7 to 8c. at St. Louis. Under normal conditions this would have meant large profits, but because of the high prices prevailing for labor and supplies, the margin of profit was not as large as the high lead prices would indicate. The district was prosperous during 1918, and the shrinkage in the tonnage was partly due to working lower-grade ores, to operating on five-sixths time in December, and, to a less extent, to the closing down of two minor producers. The influenza also curtailed work to an appreciable extent in the latter part of the year. Though labor was costly and difficult to hold to full time or efficiency, there was no pronounced shortage, despite the drafts made by the war.

Principal Output From St. Francois County

The output of 1918 was almost entirely derived from St. Francois County, as the Madison County production was much below normal and the small output from the gopher mines in the adjoining Washington, Jefferson and Franklin counties was less than usual, as the surface diggers flocked to "the big mines" in the Flat River district to enjoy the high wages.

The only entrance of new interests into the district occurred at Annapolis, in Iron County, where a St. Louis company carried out a large amount of diamond drilling in exploring a small, local limestone basin within the porphyry hills, on the main line of the Iron Mountain R.R. The area is six miles west of Madison County, and is the first deposit of disseminated lead that has been found in Iron County that promises to become of commercial importance. It resembles the Madison County deposits in general character, and though it is reported that some good cores were obtained, it is premature to estimate the probable size and richness of the deposit. Arrangements are now being made to sink a shaft upon the property, the lead ore occurring from 240 to 500 ft. in depth. The property was prospected by one of the Flat River companies four years ago, but the option was not exercised.

Although the lead market has receded considerably since the close of the war on Nov. 11, wages are still continuing on the abnormally high plane that has prevailed for over two years. An important step has been taken, however, that will render it easier to adjust the labor market with the lead market, by shutting down all the plants one day each week, thus reducing overproduction. At present, shovelers are paid $4.70 per shift of eight hours, miners $5 to $6 and common labor $4.

The soldiers who had been encamped in the district since the outbreak against the foreigners (mostly Hungarians) in 1917 were recently removed. Though at the outset there was more or less lawlessness and intimidation, to scare away the foreigners, it promptly subsided after a few days when the soldiers moved in. The continued presence of less than one company of troops has been sufficient to prevent any further trouble. That the outbreak was inspired and started by outsiders, if not by I. W. W. leaders, is now well known, and the fining or short imprisonment of some of the local participants in the trouble has completely cooled off the open antagonism to the Hungarians and Italians who largely do the heavy work or shoveling.

Mining and Milling in St. Francois County

The St. Joe Lead Co. continues to maintain its lead as the largest producer in the district, besides being the patriarch of the camp, as it is over a half-century old. The original pioneer mine at Bonne Terre, which has developed the largest orebody in the district, furnished through the No. 1 shaft a large tonnage that is concentrated at the local 2000-ton mill. The nucleus of the Bonne Terre mill was built in 1883 as a 500-ton plant, and as it has been operated continuously ever since, the removal of the tailings has become an important item, when the St. Louis demand for tailings fails. Though heavy tailing shipments are made to St. Louis for railroad ballast, concrete, and like purposes, the neighboring valleys have been largely filled up by rail haulage. As the dumping and spreading of the "chats" or tailings involves a large amount of labor, a "tailing-stacker," an endless-belt conveyor, has just been installed. This will do away with the costly train crew and chat gang, as has already been done at the other mills in the district. It will also eliminate the freezing of the tailings in the chat cars in cold weather. The No. 1 slime pond at Bonne Terre, into which all of the fine tailings and slimes are pumped, has effectively overcome the pollution of Big River, the general drainage stream of the district. The effluent that leaks through the retaining dam, which consists of a heavy bank of coarse tailings, is perfectly clear. Although the No. 1 settling pond covers over 20 acres, a second and much larger pond is under construction. It covers over 70 acres and will relieve the No. 1 pond when the latter is filled.

The 2000-ton mill at Leadwood, six miles southwest of Bonne Terre, was steadily operated in 1918 upon the output of the Leadwood mines, the most recent of the St. Joe shafts, opened about 15 years ago. The 4000-ton mill at Elvins, seven miles south of Bonne Terre, in the Flat River district, now treats the output of all the mines of the former Doe Run Co., which has been completely absorbed by the St. Joe Co., al-

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though the two companies were always closely related in ownership. Though this is the most recent of the St. Joe mills, being about six years in operation, its great capacity from the outset has resulted in the building up of a small mountain of tailings.

The Cottrell electrostatic process for smoke and fume prevention is being installed at the smeltery at Herculaneum, where other extensive improvements have been made to reduce labor costs.

The Federal Lead Co. had a busy year in 1918 at its Flat River plants, and maintained its usual large output, only exceeded by that of the St. Joe Co. It operated No. 3 mill, of 4000 tons' capacity, and the new No. 4 mill, of 3000 tons' capacity, the latter being the latest and finest concentrator in the district. Five shafts were operated, including the No. 9 shaft in the southern end of the company's property. The Keystone shoveling machine was introduced underground, and proved so satisfactory that three of the machines are now in use, resulting in a marked saving in labor. As high as 250 tons per shift has been handled by a machine, and it does not require excessive head room. A filter and drying plant for flotation concentrates was completed in the No. 3 mill in 1918. The concentrates are shipped 80 miles to Alton, Ill., where the company owns a large smeltery.

The National Lead Co. had an active, successful year, and maintained its previous output in spite of labor shortage. The 3000-ton mill not only treated the output of its own three shafts, but also the output of the Baker Lead Co.'s shaft at Leadwood. The concentrates are shipped 75 miles to its smeltery at Collinsville, in the Illinois coal belt.

The Desloge Lead Co. has been busy trying to make as large an output as the unsatisfactory labor market, with the scarcity of men and loss of time through the influenza, would permit. Its efforts have been applied to production, rather than enlargements or alterations. A Lowden drier was added to the mill for the drying of the flotation concentrates.

The Baker Lead Co., of Boston, operated its one shaft on Big River, at Leadwood, throughout 1918, and made a satisfactory record. This property, formerly known as the Jake Day land, is not equipped with a mill, and ships its ore over the M. R. & B. T. R.R. to the mill of the National Lead Co. to be concentrated.

The Boston Elvins Lead Co.'s shaft at Elvins, on Flat River, was unwatered by a multi-stage vertical centrifugal pump in 1918, but after operating for a short time and producing a limited tonnage of lead, it was shut down, and the mine is again flooded. This has been a very wet shaft, and the presence of water gave much trouble and involved heavy outlay in the sinking. It is the most recent of the operating companies. Mining has been carried on for only two short periods since the shaft was completed in 1916. It has had an incessant fight with water. The company is controlled in Boston and owns a property of 40 acres that was formerly known as the Jones tract.

The historic Mine La Motte was closed down in 1918, and seems to be in serious financial trouble. The attempt to strip 50 to 150 ft. of solid limestone overburden from over the orebody, using steam shovels, has not been a financial success. A huge rock-breaker was installed to break everything down to picking size, and the lead-bearing rock was to be picked out as the broken material was conveyed away on traveling belts. Stripping the residual clay over the outcropping limestone with steam shovels and then washing it to recover some carbonate of lead resulted in a very low-grade product, mainly of sand carrying 5 to 8% lead.

The Missouri Cobalt Co. is now actively operating the mine of the North American Lead Co. at Fredericktown, and is recovering a small amount of lead as a byproduct in producing cobalt, nickel, and copper. Small amounts of siegenite, or the sulphide of nickel and cobalt, and copper pyrites occur, associated with the lead ore, throughout the disseminated-lead belt, but in St. Francois County the quantity is too slight to be commercial. In Madison County, where granite and porphyry occur in close proximity to the lead orebodies, the mixed sulphides often amount to 2 to 5%, and are rich enough to work. The present management of the Missouri Cobalt Co. has erected an entirely new plant for the extraction of cobalt, nickel, and copper by a process of its own. The former plant of the North American Co., which produced as high as five tons of ingot copper and from one to three tons of nickel and cobalt per day, has been scrapped by the present owners, who are Canadians with experience in the Cobalt camp of Canada.

The Catherine property, two miles north of Fredericktown, has not been operated since the lease was surrendered by the Federal Lead Co. over a year ago. "Chloriders" are scrapping over the dumps. It seems doubtful if the property will ever be reopened.

Zinc Mining in Wisconsin

By J. E. Kennedy*

The net tonnage of zinc ore shipped to smelteries from the Wisconsin district in 1918 decreased 18% from that of 1917, as indicated in the accompanying table. The gross tonnage shipped from mines to smelteries and to separating plants decreased, in 1918, 24 per cent.

Ore prices in 1918 opened at $60 per ton base for premium grade of zinc ore, as against $75 per ton base for the opening week of 1917. High lead or Prime Western grade of zinc ore opened at $52 per ton base. By May 4 the base price of the premium grade had gradually declined to $50 base. During the week of May 11, and continuing up to the close of the year, the Government schedule of price for a limited quantity of premium-grade blende used in the manufacture of sheet zinc became effective in the Wisconsin district. The base price was fixed at $75 per ton for 60% grade blende not in excess of 0.15% Pb, 0.5% CaO and 1.0% Fe. Upon this basis buyers generally made a base deduction of $5 for lime in excess of 2.0% and $10 for lime in excess of 2.5%, in addition to the regular deductions of $1 per unit for lime in excess of 0.5%, and $1 per unit variation of Zn and Fe, and approximately $25 deduction per 1.0% of Pb. The highest settlement price reported paid in the open market during the year was $76.90 per ton.

A total of 58 mills and 7 separating plants were in

*Platteville, Wisconsin.

operation during 1918, as against 68 mills and 9 separating plants in 1917. Seven concentrating mills were built new or moved and reconstructed, viz. Lucky Six No. 2 (Linden), Connecting Link and Little Dick (Cuba City), Little Platte (Platteville), Dale Rundell (Livingston), Blewett (Galena), and Copeland (Shullsburg). At the close of 1918 the Zinc Hill Mining Co. was constructing a mill on the Harvey lease, Cuba City, and the Connecting Link Mining Co. was assembling material for another mill on the Coulthard tract, at Cuba City. At the year-end, W. W. Bonson, at Galena, was developing a separating process to extract the zinc content from roasted zinc tailings. The National Zinc Ore Separating Co. replaced its four Mathey roasting kilns with a multiple-hearth roaster of the Wedge type, having a capacity of 250 tons of raw ore in 24 hours. About July 15 the Government began the construction of two acid plants for the manufacture of 20% oleum. One, of 50 tons' daily capacity, at the Skinner roaster of the Wisconsin Zinc Co., was 50% completed, and the other, of 100 tons' capacity, at the National Separating plant, was 80% completed, when, in November, construction was ordered discontinued.

WISCONSIN ZINC ORE SHIPMENTS (*a*)

	Net to Smelters		Gross from Mines	
	1917	1918	1917	1918
Highland	4,868	7,659	4,868	7,659
Linden	1,454	76	16,774	5,483
Mifflin	3,170	1,242	40,237	29,910
Mineral Point	35,075	34,429	958	368
Montfort	689	.....	971	.....
Platteville	4,953	2,781	8,301	3,203
Dodgeville	522	260	1,660	1,651
Cuba City	23,881	20,523	893	1,840
Benton-New Diggings	64,582	48,123	128,047	102,747
Hazel Green	614	.....	11,868	6,070
Shullsburg	5,227	3,355	11,674	11,646
Potosi	1,978	.....	2,812	164
Galena, Ill.	1,753	405	18,930	13,094
Totals	148,766	118,853(*b*)	247,993	183,835 (*b*)

(*a*) Short tons. (*b*) Totals to Dec. 14, 1918.

Mining operations were seriously handicapped by shortage of labor up to the middle of December. The level of wages advanced over the high mark of the previous year. Experienced shovelers, at 10@12c. per can, under normal conditions, averaged $5@$6 per day. Underground drill men were paid $4@$6 per day wage and made as high as $8 on contract scale. Trammers generally received $3.50 @ $3.60 per day wage, hoistermen $4, grizzly-men $3@$3.50, crusher feeders $2.75@$3, and mill men $100@$150 per month.

Comparatively little prospecting was carried on throughout 1918. Shortage of labor was somewhat offset by the installation of more power shovels of the Thew and Keystone types. The year's production record was held by the Hoskins, the youngest producer of the Mineral Point Zinc Co.'s group, which made a shipment total of 15,371 tons blende, reported to Dec. 14. The Champion mine, of the Wisconsin Zinc Co., and the Yewdall mine, of the Vinegar Hill Zinc Co., were close behind.

German Supplies and Prices of Metals

According to the *Ironmonger*, all stocks of metals in the possession of manufacturers have been freed from control, but the supplies held by the War Metal Co. of copper, aluminum, nickel, spelter, tin, and lead are doled out in lots of not more than 25 kg. (½ cwt.), and only against an official permit. Every German manufacturer of finished articles, whether he belongs to a trade association or not, is entitled to a supply of the metal he requires representing a fixed percentage of his normal consumption. The prices per 100 kg., fixed by the State Demobilization Department, are as follows: Copper, 450 marks (equal to £225 per ton); tin, 1400 marks (£700); nickel, 1500 marks (£750); lead, 76 marks (£38); spelter, 130 marks (£65); refined zinc, (99.9), 158 marks (£79); antimony, 230 marks (£115); aluminum, 700 marks (£350); and platinum, 24 marks per gram. The selling prices will be adjusted as soon as possible to those ruling in the markets of the world and will be published from time to time. The allotment forms will also entitle the holders to import metals from abroad, instead of buying them from the War Metal Co. The metals supplied for war purposes by the War Metal Co., the Spelter Works' Association and the Association of German Zinc Rolling Works have hitherto been delivered to the manufacturers at less than the cost prices, but as they are henceforth to be supplied only for civil industry, the Demobilization Department has decided that there is no further need to sell them at less than their value. Hence, the owners will be charged with the difference between the preferential prices and the quotations that have now been fixed for all metal in stock on Nov. 13. Those who are unwilling to pay the difference may return the stock to the War Metal Company.

Uranium and Radium in 1918

Uranium is the chief source of radium, and is principally found as the mineral carnotite in southwestern Colorado, in San Miguel, Dolores, Montrose, and Mesa counties, and in Utah, in San Juan, Grand, and Emery counties. A new deposit is being developed in the State of Washington. The demand is so small that domestic production can easily be increased. The principal ores are carnotite, samarskite (or pitchblende), and uvanite. According to the testimony given at the hearing before the Committee on Mines and Mining of the U. S. Senate, 600 tons of ore are required to produce one gram of radium. The average uranium content of the Colorado and Utah ores varies from one-half of 1% to 2%. The total production of radium from 1908 to 1917 was only 25 gm. In 1917 the production was 12 gm. and the probable amount in 1918, 25 gm. Each gram is worth approximately $100,000.

Uranium is used industrially in the manufacture of ceramics, colored glazes, glass, gas mantles, as a chemical reagent for miscellaneous purposes and in the textile industry as a mordant in dyeing. The chief alloys of uranium are ferro-uranium and uranium carbide, which acts as a catalyst in the production of ammonia from nitrogen and hydrogen. The principal salts of uranium are the oxide, containing 95% U_3O_8 and selling for $5 per lb. per uranium content (previous to the war the price was $3.60); and uranate of soda, containing 80% U_2O_3, and selling for $4.50 per lb. Ferro-uranium, composed of 25 to 30% uranium, 21% silicon, and 4 to 5% carbon, has a market price of $7.50 per pound.

The industrial uses of radium include its application to the manufacture of luminous dials for compasses, watches, and clocks, gun sights and to instruments of precision that are part of the equipment of submarines, aëroplanes, and naval and other vessels.